SDOT
Seattle Department of Transportation

Technical Memorandum – Final

To: Matt Donahue, P.E., SDOT Roadway Structures Manager

From: Stephen Wilson, P.E., S.E./SDOT Engineering Services
Cc: Yuling Teo, P.E./SDOT Engineering Services Structures Design Manager
Richard Long/SDOT Engineering Services

Date: November 12, 2018

Re: 1st Avenue Areaways Evaluation

The purpose of this memorandum is to summarize the review and analysis of the areaways along 1st Avenue S. This evaluation was performed by SDOT Engineering Services staff to support SDOT Roadway Structures in assessing the areaways' suitability to support bus service along the road. The work consisted primarily of reviewing previous areaway studies and if deemed appropriate, preparing independent analyses with different assumptions to understand how it may affect the results.

The previous study that focused on bus use on 1st Ave. S. was the *First Avenue Areaways Assessment* by Chudgar Engineering, 2014 (2014 Study). This study concluded that the areaway walls need strengthening to support bus loading placed in the lane directly adjacent to the curb. That study also mentioned that buses placed one lane away from the curb lane would pose less risk to the areaway walls. Other relevant studies include *Structural Design Memorandum 30% Preliminary Center City Connector Streetcar* prepared by Chudgar Engineering, 2015 (2015 Study) and the *Geotechnical Engineering Report Draft 30% Preliminary Center City Connector Streetcar* prepared by Shannon and Wilson, 2015 (2015 Geotechnical Report).

The interim bus route is a temporary re-route of select Metro bus lines during SR-99 Viaduct Demolition. The route along 1st Ave. S. will be between Columbia St. and S. Dearborn St. and will be in both the north and south directions. The re-route is anticipated to last for up to one year but is contingent on the schedules of the project. Areaways exist along both sides of the road for nearly the entire stretch of 1st. Ave. S. between Columbia Street and King Street.

Revised Assumptions

After reviewing the 2014 Study, it was determined that several design assumptions and values could be revised. The most significant assumptions that were deemed appropriate to revise are summarized in Table 1 below.

Table 1: Revised Assumptions

Topic	2014 Study Assumption/Value	Revised Assumption/Value	Justification
1) Wall Support Conditions	Wall behaves as cantilever beam, fixed at its base.	Wall behaves as a supported beam with a lateral restraint at the top and fixed at the base.	The sidewalk and supporting steel beams are connected to the top of the areaway wall, providing a lateral support. This was confirmed during the site visit and review of existing photos.
2) Earth Pressure Loads	"Active" earth pressures used (40H psf)	"At-rest" earth pressures used (60H psf)	If Assumption #1 is to be incorporated, higher "at-rest" lateral earth pressures must be used.

Topic	2014 Study Assumption/Value	Revised Assumption/Value	Justification
3) Bus Loads	725 psf peak lateral surcharge pressure	1,415 psf peak lateral surcharge pressure	SDOT's independent check of the bus loading resulted in higher lateral pressures from buses adjacent to the wall. Current data provided by KC Metro show heavier buses than were used in the 2014 Study.
4) Live Load on Sidewalk	250 psf pedestrian live load on sidewalk for sliding and bearing capacity checks	75 psf pedestrian live load on sidewalk bearing capacity checks	A 250 psf live load is required by the Right of Way Manual for sidewalks subjected to trucking. The sidwalks are not likely adequate for truck loading so the load was reduced to 75 psf. Where this load is a benefit to the wall (i.e. sliding resistance), it should be omitted altogether. Where it increases loading on the wall or foundation (i.e. bearing capacity), 75 psf is considered.
5) Wall Material Properties	Masonry compressive and tensile strengths	Reduced nominal values.	The nominal material strengths used in the 2014 study appear closer to what current designs would be based on and are likely higher than in the early 1900's. The properties of masonry and mortar used in the analysis is subject to judgment as no as built or reliable historical data exists to verify. Field testing could be done to confirm. **Check with SDCI to see what masonry strengths are assumed for 1900-era buildings that were seismically retrofitted.**
6) Condition Factors	Reduced strengths of concrete by a 0.6 factor and masonry by a 0.3 factor to account for deteriorated condition	Use 0.75 for concrete and 0.6 for masonry	This is based on judgment. The walls inspected as part of this evaluation appeared to be in fair condition. Deterioration of the masonry mortar over the years due to moisture has likely occurred, but a 0.3 factor is considered here to be too conservative.
7) Wall Dimensions	18" thick concrete wall, 12" thick brick wall, 26" thick stone masonry (i.e. rubble) wall	Brick wall is likely closer to 24" thick. No change for concrete and stone masonry	We measured the brick wall thickness at one areaway – A202 to be approximately 26". Other areaways with brick walls have not been confirmed.

Analysis Methodology

Independent analysis of the walls was done incorporating the revised assumptions. The walls were evaluated according to AASHTO methodologies for global stability which includes lateral sliding, overturning, and bearing pressure and internal stability which includes shear and moment capacity. The revised assumptions were applied to the analysis and capacity over demand (C/D) ratios were calculated and compared to the initial 2014 Study.

Applied Loads

The revised analysis included loads as follows:

- Dead loads (sidewalks, wall self weight)
- Lateral earth pressure – Based on 2015 Geotechnical Report
- Metro buses – Bus data from King County Metro and applied per AASHTO LRFD 3.11.6.2
- AASHTO Legal Loads – AASHTO Type 3, 3-3, and 3S2 and applied per AASHTO LRFD 3.11.6.2
- AASHTO prescribed live load surcharge per AASHTO LRFD 3.11.6.1
- Pedestrian load on sidewalk

In addition to buses, the AASHTO legal truck and the AASHTO live load surcharge were included in the wall analysis. Presumably, truck loads up to the legal limit are allowed along 1st Ave. S. Therefore, the walls have likely been exposed to these trucks for some time. The AASHTO live load surcharge is used for new designs and is included for comparison purposes.

Seismic loads and normal traffic loads, such as passenger cars and trucks, are not included in this analysis.

See Attachment 1 for loading diagrams used in the analysis.

Areaways Reviewed

The revised analysis considered seven areaways along 1st Ave. S. – A202, A301, A902, A1201, A1703, A2001C, and A401. The first six of those are listed as having 'restorable' (meaning in fair to poor condition) street walls per the 2008 Areaways Base Map and were included in the 2014 Study. A401 was added because it is at the corner where the buses will make a right turn going east on Cherry St.

Table 2: Areaway Data

Areaway	Street Wall Type	Street Wall Ht.
202	Brick	11
301	Rubble w/ Conc. Facing	10.5
902	Rubble w/ Conc. Facing	10.75
1201	Concrete	12.5
1703	Brick	8.75
2001C	Concrete	11.25
401	Concrete	9.5

For purposes of this evaluation, three wall types were analyzed – 1) concrete, 2) brick, or 3) rubble, and the maximum wall height were used for each wall type. Because numerous areaways are located along 1st, this was considered an appropriate simplification intended to evaluate the general suitability of all the areaways along 1st. If retrofit is pursued to strengthen the walls, a more refined, case-by-case, evaluation will likely be warranted.

Rubble walls were analyzed similar to brick walls with the mortar tensile and shear capacity controlling the internal flexure and shear capacities. We did not perform analysis for rubble walls acting as rockery walls (where there is no tensile capacity between the stones) because Revised Assumption #1, #2, #5, and #6 would not apply and the results would be very similar to the 2014 Study.

The analysis included a site visit to areaways 202, 301, and 401 to inspect the condition of the walls and to confirm the revised assumptions above. These areaways were selected for a site visit because they represent a concrete wall, a brick wall, and a rubble wall.

Analysis Results

Even with the reduced loading and increased wall thickness, C/D ratios remain less than 1.0 for certain external and internal stability checks. For internal stability, flexure in the walls is the critical action, with brick and stone masonry (rubble) walls having the lowest C/D ratios. Unreinforced masonry has limited flexural strength because the mortar and mortar-to-brick/stone bond have limited tensile strength. Unreinforced masonry is not typically used for members subjected to out of plane bending and are mostly used as bearing or shear walls. For external stability, C/D ratios for sliding decreased due inclusion of Revised Assumption #4 above.

The Metro bus load is the controlling live load and C/D ratios are presented below. C/D ratios for AASHTO Legal Loads, which are intended to capture freight loads, are also shown below. The AASHTO Live Load Surcharge, which is intended to capture the design live load, is shown in Attachment 1. The following C/D ratios are shown as a factored load case and an unfactored load case. The unfactored load case is intended to show a potential lower bound on the applied loads. The factored load case is consistent with AASHTO LRFD Strength Limit State II which is intended for owner-specified permit vehicles where specific details of the vehicle are known. For comparison, the design of a new structure for normal vehicular use uses a live load factor of 1.75.

C/D Ratios – Metro Bus Loading

AASHTO LRFD Strength II Limit State
Live Load Factor (LS) = 1.35
Earth Pressure Factor (EH) = 1.35
Strength Reduction Factor, F_{str} = 0.6 to 0.8; Condition Factor, F_{cond} = 0.75 for concrete, 0.6 for masonry

$$\frac{Capacity}{Demand} = \frac{F_{str} * F_{cond} * R_n}{1.35 * LS + 1.35 * EH}$$

Table 3: C/D Ratios for Strength II Limit State

Areaway	Flexure	Shear	Sliding	Bearing
Concrete Walls (A1201, A2001C, A401)	**.42** (.17)	**1.03** (1.16)	**.28** (.56)	**.25** (.08)
Brick Walls (A202, A1703)	**.18** (.01)	**2.81** (1.79)	**.33** (.53)	**.49** (.06)
Rubble Walls (A301, A902)	**.20** (.08)	**2.81** (4.83)	**.38** (.83)	**.48**(.22)

*Values in () are from the 2014 Study

Unfactored Load Case
Live Load Factor (LS) = 1.0
Earth Pressure Factor (EH) = 1.0
Strength Reduction Factor, F_{str} = 0.6 to 0.8; Condition Factor, F_{cond} = 0.75 for concrete, 0.6 for masonry

$$\frac{Capacity}{Demand} = \frac{F_{str} * F_{cond} * R_n}{1.0 * LS + 1.0 * EH}$$

Table 4: C/D Ratios for Unfactored Loads

Areaway	Flexure	Shear	Sliding	Bearing
Concrete Walls (A1201, A2001C, A401)	**.56** (.27)	**1.41** (1.71)	**.41** (.81)	**.32** (.22)
Brick Walls (A202, A1703)	**.24** (.01)	**3.79** (2.61)	**.49** (.73)	**.62** (.19)
Rubble Walls (A301, A902)	**.27** (.10)	**3.79** (7.56)	**.57** (1.22)	**.60** (.61)

*Values in () are from the 2014 Study

C/D Ratios – Legal Loads

AASHTO LRFD Strength II Limit State
Live Load Factor (LS) = 1.35
Earth Pressure Factor (EH) = 1.35
Strength Reduction Factor, F_{str} = 0.6 to 0.8; Condition Factor, F_{cond} = 0.75 for concrete, 0.6 for masonry

$$\frac{Capacity}{Demand} = \frac{F_{str} * F_{cond} * R_n}{1.35 * LS + 1.35 * EH}$$

Table 5: C/D Ratios for Strength II Limit State

Areaway	Flexure	Shear	Sliding	Bearing
Concrete Walls (A1201, A2001C, A401)	**.48**	**1.13**	**.30**	**.28**
Brick Walls (A202, A1703)	**.21**	**3.14**	**.36**	**.55**
Rubble Walls (A301, A902)	**.23**	**3.14**	**.42**	**.54**

*Values in () are from the 2014 Study

Unfactored Load Case
Live Load Factor (LS) = 1.0
Earth Pressure Factor (EH) = 1.0

$$\frac{Capacity}{Demand} = \frac{F_{str} * F_{cond} * R_n}{1.0 * LS + 1.0 * EH}$$

Strength Reduction Factor, F_{str} = 0.6 to 0.8; Condition Factor, F_{cond} = 0.75 for concrete, 0.6 for masonry

Table 6: C/D Ratios for Unfactored Loads

Areaway	Flexure	Shear	Sliding	Bearing
Concrete Walls (A1201, A2001C, A401)	**.64**	**1.53**	**.45**	**.36**
Brick Walls (A202, A1703)	**.28**	**4.24**	**.55**	**.69**
Rubble Walls (A301, A902)	**.31**	**4.24**	**.63**	**.67**

*Values in () are from the 2014 Study

Existing conditions

The results above include effects of the existing soil and the proposed Metro bus. Below is an evaluation of walls under existing loading conditions. Existing loading is considered to be soil combined with passenger cars and trucks. Delivery trucks and other heavier vehicles may occasionally park in the lane adjacent to the wall but are not assumed to be routine loadings. C/D ratios are calculated assuming nominal loads and assumed nominal capacities (i.e. unfactored loads and unfactored capacities). The purpose of the analysis is to compare current loading conditions to relate to recently observed conditions.

The walls included in the 2014 Study have varying levels of deterioration, and to date, two areaways along 1st Ave S. (A904 and A905) have been filled due to extensive deterioration.

C/D Ratios – Routine Traffic Loading (Passenger Cars and Trucks)

Unfactored Loads
Live Load Factor (LS) = 1.00
Earth Pressure Factor (EH) = 1.00

$$\frac{Capacity}{Demand} = \frac{F_{str} * F_{cond} * R_n}{1.0 * LS + 1.0 * EH}$$

Strength Reduction Factor, F_{str} = 1.0; Condition Factor, F_{cond} = 1.0

Table 7: C/D Ratios for Unfactored Loads and Unfactored Capacities under Passenger Vehicle Traffic Loading

Areaway	Flexure	Shear	Sliding	Bearing
Concrete Walls (A1201, A2001C, A401)	**>1.0**	**>1.0**	**0.54**	**0.44**
Brick Walls (A202, A1703)	**0.67**	**>1.0**	**0.68**	**0.85**
Rubble Walls (A301, A902)	**0.72**	**>1.0**	**0.82**	**0.78**

*Values in () are from the 2014 Study

The C/D ratios for brick and rubble walls are still less than 1.0 which would could imply that the assumptions used for shear and moment capacity are conservative. The analysis initially assumed a nominal mortar tensile strength of 30 psi prior to accounting for deterioration. In order for the C/D ratios in Table 7 to be 1.0, the nominal mortar tensile strength would need to be 50 psi and not reduced for deterioration. In order for the C/D ratios in Table 3 to reach 1.0, the nominal mortar tensile strength would need to be approximately 250

psi. This value is not deemed appropriate for these walls. If 50 psi is used in the Table 3 load combinations, the C/D ratios are still less than 1.0.

Conclusions and Considerations

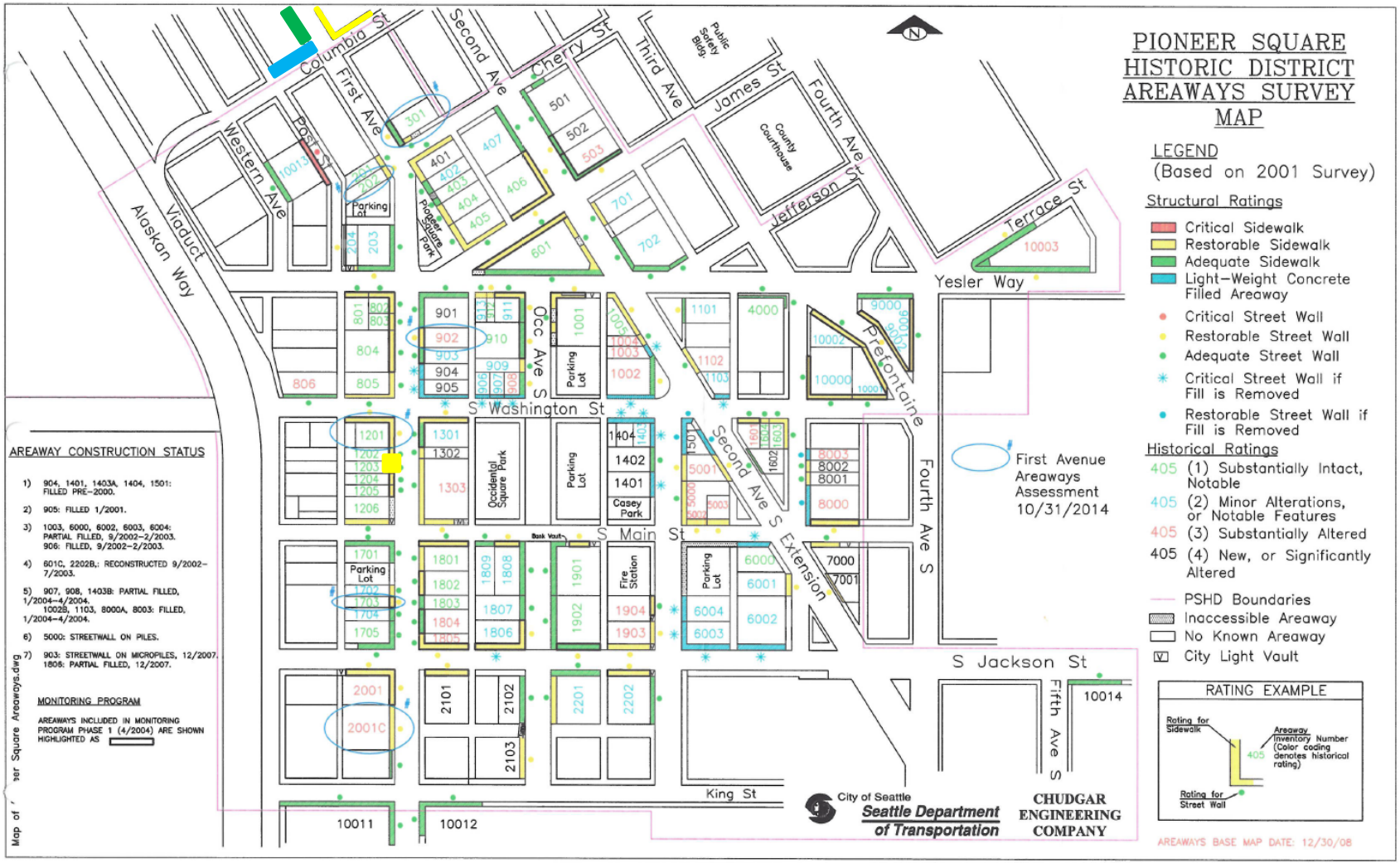
Based on review of the existing reports, a site visit of three of the areaways, and structural analysis of the walls, the primary conclusions from the evaluation are as follows:

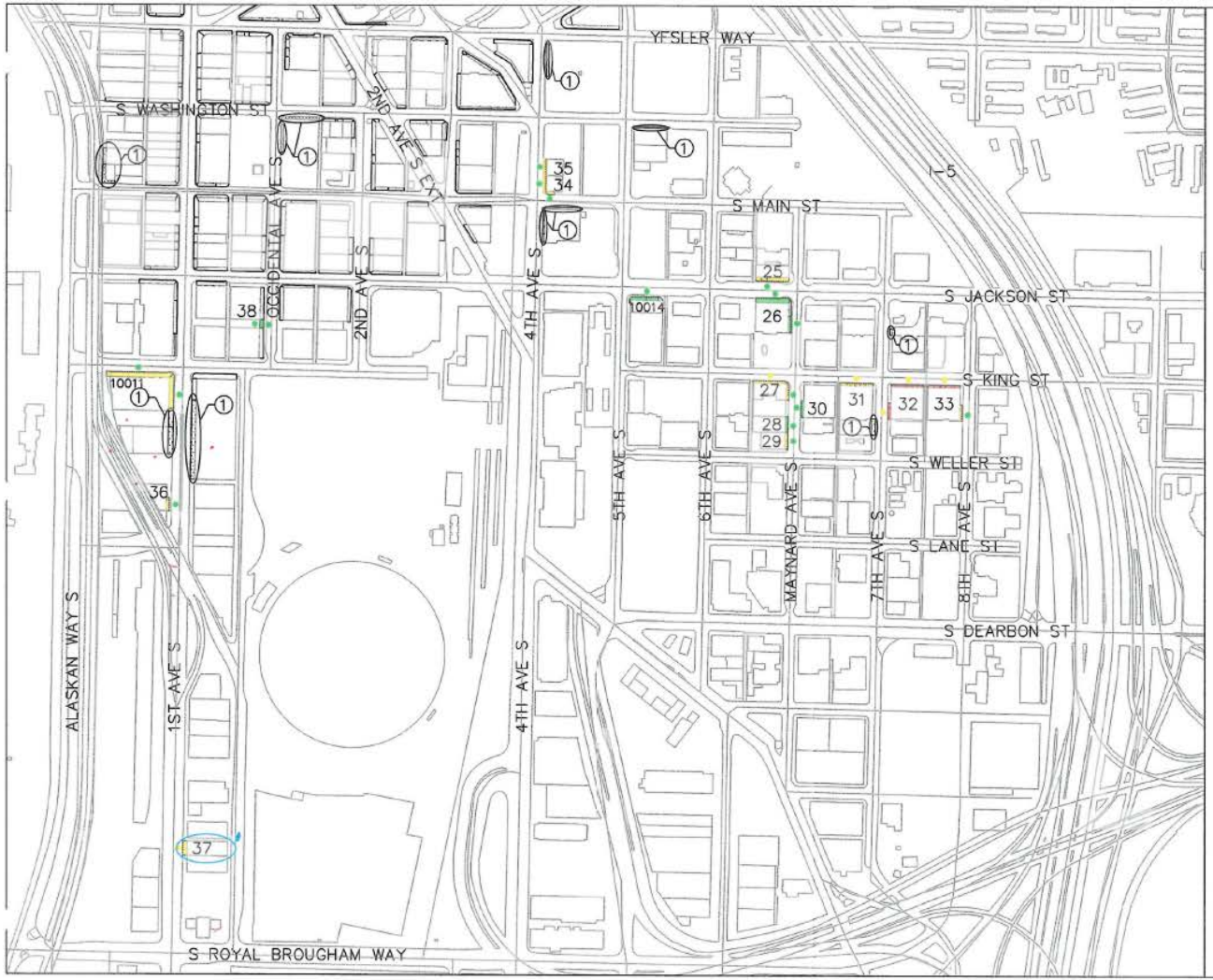
- The analysis that incorporates the revised assumptions above indicate that the loading demand exceeds the walls' capacity for flexure and external stability for all wall types and for both factored and unfactored loads. The walls could be at risk of being damaged or failing if subjected to repeated bus loading.
- Our analysis concurs with the 2014 Study that a bus in the lane away from the curb significantly reduces live loads on the wall. At 10' away, the increased load is considered negligible.
- Even if buses are not permitted in the curbside lane, turning movements at the 1st Ave. S./Cherry St. intersection need to be evaluated because they could result in the bus travel way being near the curb. Traffic control measures may be needed to keep buses a minimum distance away from the curb.
- Brick and stone masonry (rubble) walls appear the most vulnerable to increased loading due to limited flexure capacity.
- Sliding C/D ratios decreased from the 2014 Study due to omission of the pedestrian load on the sidewalk, but many of the areaways have concrete floors which would help to resist sliding forces. The floors and passive resistance in front of the walls was neglected.
- Bearing C/D ratios must be verified with additional geotechnical input regarding bearing capacities below the areaway walls.
- Adding bus loads to the existing earth loads results in an increase in loading of approximately 30%.
- Although not presented explicitly in this report our analysis also indicates that legal HS20 truck loads combined with deadload result in C/D ratios significantly less than 1.0. This indicates that freight access should be restricted along 1st Avenue near areaways.
- If live loads are completely removed from the analysis (LS = 0), the controlling C/D ratios are still less than 1.0 for masonry wall flexure and external stability. However, the areaways that were inspected appear to be in fair condition based on visual inspection and appear to be performing satisfactorily under current conditions which do not include bus or freight loading.
- It is also worth noting that historical Roadway Structures asset inventory data indicates that approximately 40 areaways have either been strengthened or filled with concrete in the past as a result of excessive deterioration possibly due to excessive stress induce by heavy vehicle loading.

Attachments

Attachment 1 – 1st Avenue South Areaway Map
Attachment 2 – Loading Diagrams and Structural Calculations
Attachment 3 – Photos

Attachment 1 – 1st Avenue South Areaway Map


PIONEER SQUARE HISTORIC DISTRICT AREAWAYS SURVEY MAP
LEGEND
(Based on 2001 Survey)
Structural Ratings
Critical Sidewalk
Restorable Sidewalk
Adequate Sidewalk
Light-Weight Concrete Filled Areaway
Critical Street Wall
Restorable Street Wall
Adequate Street Wall
Critical Street Wall if Fill is Removed
Restorable Street Wall if Fill is Removed
Historical Ratings
405 (1) Substantially Intact, Notable
405 (2) Minor Alterations, or Notable Features
405 (3) Substantially Altered
405 (4) New, or Significantly Altered
PSHD Boundaries
Inaccessible Areaway
No Known Areaway
City Light Vault
RATING EXAMPLE
Rating for Sidewalk
Areaway Inventory Number (Color coding denotes historical rating.)
405
Rating for Street Wall
AREAWAY CONSTRUCTION STATUS
1) 904, 1401, 1403A, 1404, 1501: FILLED PRE-2000.
2) 905: FILLED 1/2001.
3) 1003, 6000, 6002, 6003, 6004: PARTIAL FILLED, 9/2002-2/2003. 906: FILLED, 9/2002-2/2003.
4) 601C, 2202B,: RECONSTRUCTED 9/2002-7/2003.
5) 907, 908, 1403B: PARTIAL FILLED, 1/2004-4/2004. 1002B, 1103, 8000A, 8003: FILLED, 1/2004-4/2004.
6) 5000: STREETWALL ON PILES.
7) 903: STREETWALL ON MICROPILES, 12/2007. 1806: PARTIAL FILLED, 12/2007.
MONITORING PROGRAM
AREAWAYS INCLUDED IN MONITORING PROGRAM PHASE 1 (4/2004) ARE SHOWN HIGHLIGHTED AS
First Avenue Areaways Assessment 10/31/2014
City of Seattle
Seattle Department of Transportation
CHUDGAR ENGINEERING COMPANY
AREAWAYS BASE MAP DATE: 12/30/08
Columbia St
Second Ave
Cherry St
Third Ave
James St
Fourth Ave
Jefferson St
Terrace St
Yesler Way
Western Ave
Post St
First Ave
Alaskan Way Viaduct
Occ Ave S
Prefontaine
S Washington St
S Main St
Second Ave S Extension
Fourth Ave S
S Jackson St
Fifth Ave S
King St
Public Safety Bldg.
County Courthouse
Parking Lot
Occidental Square Park
Pioneer Square Park
Casey Park
Fire Station
Bank Vault



STRUCTURAL RATING
SIDEWALK
- ADEQUATE SIDEWALK
- RESTORABLE SIDEWALK
- CRITICAL SIDEWALK
- FILLED SIDEWALK

STREET WALL
- ADEQUATE SIDEWALK
- RESTORABLE SIDEWALK
- CRITICAL SIDEWALK
- FILLED SIDEWALK

① NO AREAWAY PRESENT (EITHER FILLED, REHABILITATED OR REMOVED)

First Avenue Areaways Assessment 10/31/2014

N

AREAWAYS INSPECTION

INTERNATIONAL DISTRICT, SOUTH OF YESLER WAY, PIONEER SQUARE

INSPECTION PERFORMED:
OCTOBER, 2008– FEBRUARY, 2009

MAP DATE:
FEBRUARY 23, 2009

City of Seattle
Seattle Department of Transportation

CHUDGAR ENGINEERING COMPANY

Attachment 2 – Design Information and Structural Calculations

1st Avenue Areaways Analysis

Scope:

Revise wall analysis from 2014 Study based on new assumptions regarding wall support conditions, material properties, and loading.

Calculate shear and moment on retaining walls consisting of unreinforced concrete, brick masonry, and rubble masonry.

These calcs. are independent QAQC calculations for the RISA model loading but are the primary calculations for the wall section capacity.

Codes, Standards, and References:

AASHTO LRFD Bridge Design Specifications
2015 Geotechnical Report for C3 Streetcar
ACI 318 Building Code Requirements for Concrete Structures
ACI 530 Building Code Requirements for Masonry Structures

Notes:

Concrete walls were analyzed for a height (H) of 13'.
Masonry walls were analyzed for a height (H) of 11'.
Pin-Fix support conditions assumed and control over Pin-Pin
Cantilever loading included for comparison only.

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Additional Information:

Loading diagram
AASHTO LRFD excerpts
Geotech information
Bus and legal load surcharge calculations
KC Metro Bus Loading Specs

Areaway Data and 2014 Study Results

Areaway	Address	Business/Building	Street Wall Type	Street Wall Height to Top of Floor	Sidewalk?	Floor?
37	1020 1st Ave. S		Concrete	9	Yes - RC Conc. w/ Steel Beams	
202	625 1ST AVE	Emerald City Building	Brick	11	Yes - Brick arches with Steel Beams	Dirt
301	102 Cherry Street	Spooked in Seattle Tours and Museum	Rubble w/ Conc. Facing	10.5	Yes - RC Conc. w/ Steel Beams	
902	104 1st Ave. S	Lippy Building	Rubble w/ Conc. Facing	10.75	Yes - RC Conc. w/ Steel Beams	
1201	201 1ST AVE S	J and M Café and Restaurant	Concrete	12.5	Yes - Brick arches with Steel Beams	
1703	314 1ST AVE S	Crown Building	Brick	8.75	Yes - Brick arches with Steel Beams	
20001C	411 1ST AVE S	Merrill Place	Concrete	11.25	Yes - Composite Metal Deck w/ steel beams	
401	107 CHERRY ST		Concrete	9.5		Concrete

Areaway 37
No live load included

External Stability C/D Ratios

		Sliding	Overturning	Bearing
Strength	I	0.77	0.46	0.37
Strength	II	0.7	0.44	0.37
Strength	III	0.49	0.37	0.35
Strength	IV	0.49	0.37	0.38
Strength	V	0.7	0.44	0.37
Extreme	I	0.67	0.39	0.4
Extreme	II	0.79	0.54	0.52
Service	I	1.05	0.67	1.13
Service	II	1.12	0.7	1.15
Service	III	1.01	0.66	1.12
Service	IV	0.82	0.6	1.07

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	1.84	0.45
Strength	II	1.84	0.45
Strength	III	1.84	0.45
Strength	IV	1.84	0.45
Strength	V	1.84	0.45
Extreme	I	1.87	0.4
Extreme	II	1.84	0.45
Service	I	2.76	0.68
Service	II	2.76	0.68
Service	III	2.76	0.68
Service	IV	2.76	0.68

Areaway Data and 2014 Study Results
Areaway A202

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.57	0.17	0.06
Strength	II	0.53	0.17	0.07
Strength	III	0.34	0.2	0.13
Strength	IV	0.34	0.2	0.13
Strength	V	0.53	0.17	0.07
Extreme	I	0.5	0.18	0.13
Extreme	II	0.58	0.25	0.15
Service	I	0.73	0.24	0.19
Service	II	0.77	0.23	0.16
Service	III	0.71	0.25	0.21
Service	IV	0.59	0.32	0.37

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	1.67	0.01
Strength	II	1.79	0.01
Strength	III	2.34	0.02
Strength	IV	2.34	0.02
Strength	V	1.79	0.01
Extreme	I	1.64	0.01
Extreme	II	2.1	0.01
Service	I	2.61	0.01
Service	II	2.43	0.01
Service	III	2.76	0.01
Service	IV	3.51	0.03

Areaway 301A

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.88	0.37	0.19
Strength	II	0.85	0.4	0.23
Strength	III	0.73	0.6	0.67
Strength	IV	0.73	0.6	0.85
Strength	V	0.85	0.4	0.23
Extreme	I	0.92	0.5	0.42
Extreme	II	1.08	0.69	0.57
Service	I	1.24	0.6	0.64
Service	II	1.24	0.54	0.53
Service	III	1.24	0.65	0.76
Service	IV	1.23	0.98	2.5

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	3.86	0.04
Strength	II	4.15	0.05
Strength	III	5.54	0.09
Strength	IV	5.54	0.09
Strength	V	4.15	0.05
Extreme	I	3.85	0.05
Extreme	II	4.93	0.07
Service	I	6.05	0.06
Service	II	5.59	0.06
Service	III	6.4	0.08
Service	IV	8.31	0.14

Areaway Data and 2014 Study Results
Areaway A902

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.86	0.36	0.18
Strength	II	0.83	0.39	0.22
Strength	III	0.71	0.58	0.59
Strength	IV	0.71	0.58	0.73
Strength	V	0.83	0.39	0.22
Extreme	I	0.9	0.49	0.39
Extreme	II	1.05	0.66	0.53
Service	I	1.22	0.58	0.61
Service	II	1.22	0.53	0.5
Service	III	1.21	0.63	0.71
Service	IV	1.2	0.94	2.13

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	4.83	0.07
Strength	II	5.17	0.08
Strength	III	6.84	0.14
Strength	IV	6.84	0.14
Strength	V	5.17	0.08
Extreme	I	4.76	0.08
Extreme	II	6.11	0.11
Service	I	7.56	0.1
Service	II	7	0.1
Service	III	7.98	0.12
Service	IV	10.26	0.21

Areaway A1201A

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.59	0.19	0.07
Strength	II	0.56	0.2	0.08
Strength	III	0.42	0.25	0.14
Strength	IV	0.42	0.25	0.14
Strength	V	0.56	0.2	0.08
Extreme	I	0.56	0.22	0.14
Extreme	II	0.66	0.31	0.16
Service	I	0.81	0.29	0.22
Service	II	0.83	0.27	0.19
Service	III	0.79	0.31	0.24
Service	IV	0.71	0.4	0.4

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	1.1	0.17
Strength	II	1.16	0.19
Strength	III	1.45	0.31
Strength	IV	1.45	0.31
Strength	V	1.16	0.19
Extreme	I	1.35	0.23
Extreme	II	1.33	0.25
Service	I	1.71	0.27
Service	II	1.61	0.24
Service	III	1.79	0.3
Service	IV	2.17	0.47

Areaway Data and 2014 Study Results

Areaway A1703

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.71	0.22	0.1
Strength	II	0.67	0.23	0.12
Strength	III	0.44	0.3	0.28
Strength	IV	0.44	0.3	0.29
Strength	V	0.67	0.23	0.12
Extreme	I	0.64	0.26	0.23
Extreme	II	0.74	0.36	0.27
Service	I	0.9	0.32	0.31
Service	II	0.93	0.3	0.26
Service	III	0.88	0.34	0.35
Service	IV	0.75	0.49	0.82

Internal Stability C/D Ratios

		Shear	Moment
Strength	I	2.24	0.01
Strength	II	2.45	0.02
Strength	III	3.62	0.03
Strength	IV	3.62	0.03
Strength	V	2.45	0.02
Extreme	I	2.42	0.02
Extreme	II	3.07	0.02
Service	I	3.55	0.02
Service	II	3.21	0.02
Service	III	3.81	0.02
Service	IV	5.43	0.05

Areaway A2001C

External Stability C/D Ratios

		Sliding	Overtuning	Bearing
Strength	I	0.66	0.22	0.09
Strength	II	0.62	0.23	0.1
Strength	III	0.47	0.3	0.2
Strength	IV	0.47	0.3	0.21
Strength	V	0.62	0.23	0.1
Extreme	I	0.63	0.27	0.18
Extreme	II	0.73	0.36	0.21
Service	I	0.89	0.34	0.28
Service	II	0.91	0.31	0.24
Service	III	0.87	0.35	0.31
Service	IV	0.79	0.48	0.58

Internal Stability C/D Ratios

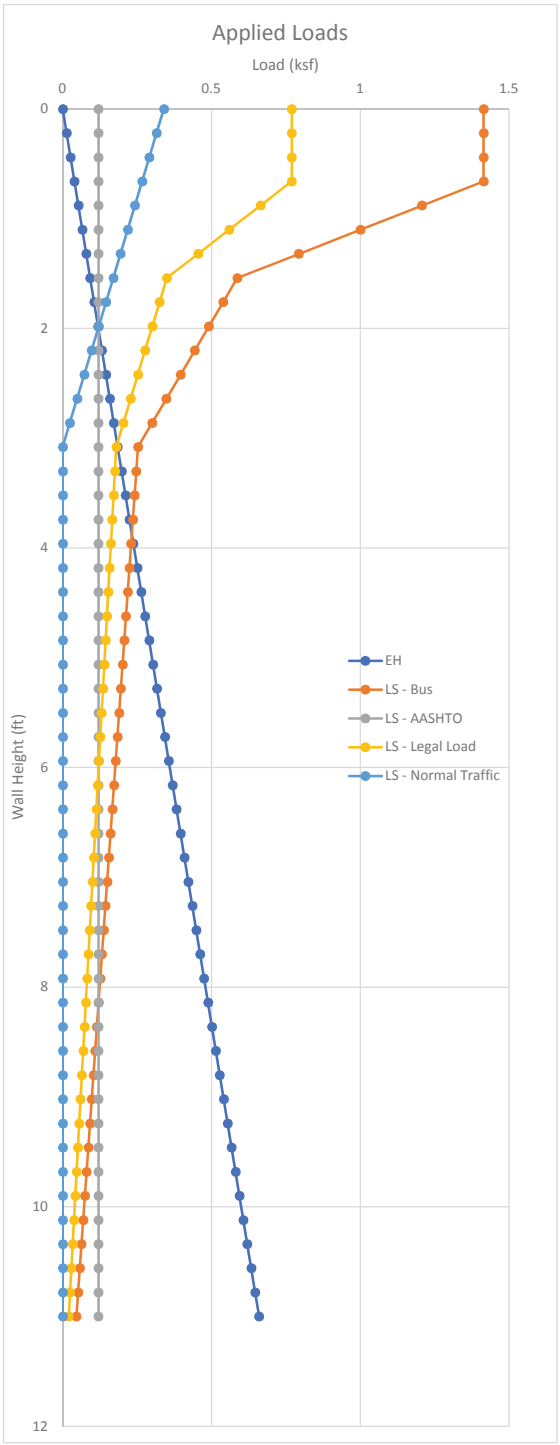
		Shear	Moment
Strength	I	1.48	0.24
Strength	II	1.58	0.28
Strength	III	2.04	0.49
Strength	IV	2.04	0.49
Strength	V	1.58	0.28
Extreme	I	1.87	0.34
Extreme	II	1.84	0.38
Service	I	2.31	0.39
Service	II	2.15	0.35
Service	III	2.43	0.43
Service	IV	3.07	0.73

Loading Analysis

Compare Cantilever Loading vs. Simply Supported and Fix-Pin Supported

Loading			
Soil	gamma	120	
	phi	32	
EH	ko	0.5	
LS - AASHTO		120	PSF
H		11	feet

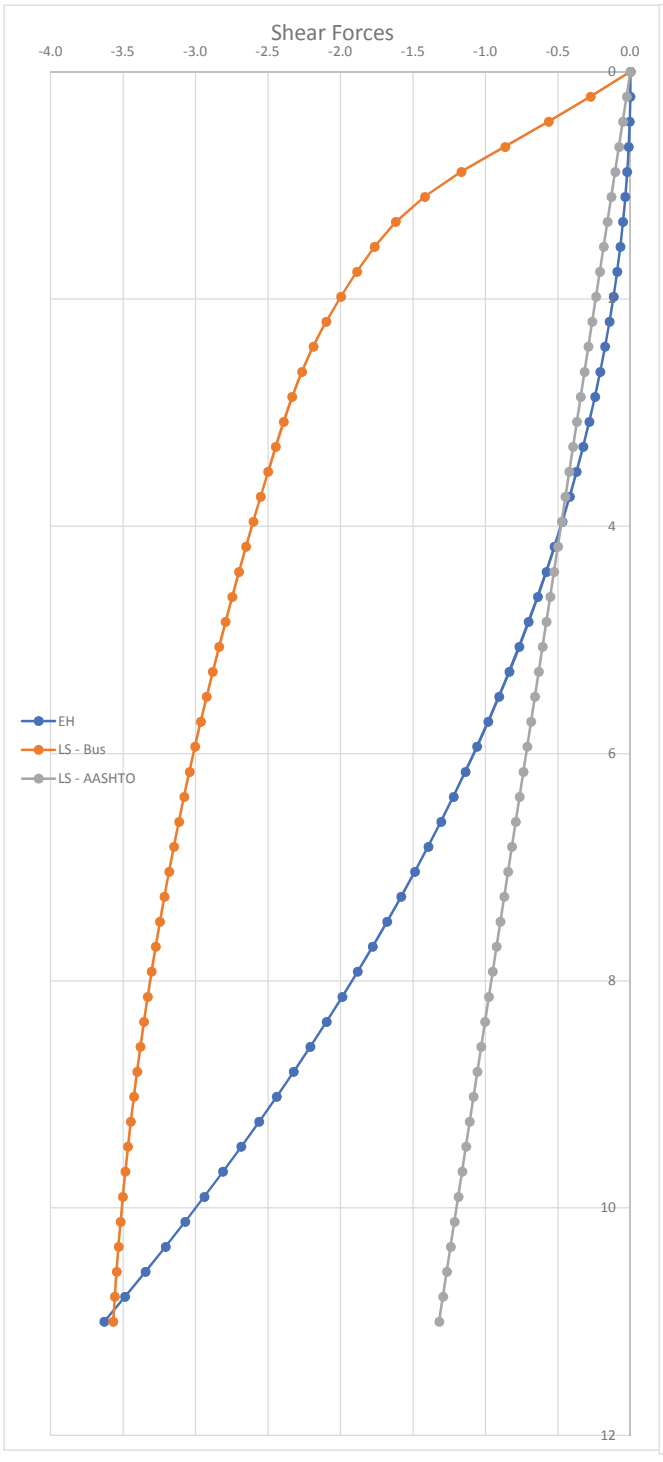
H	EH - Tri	LS - AASHTO	LS - Bus	LS - Legal Load	LS - Normal Traffic
0	0	0.12	1.41	0.77	0.34
0.22	0.0132	0.12	1.41	0.77	0.32
0.44	0.0264	0.12	1.41	0.77	0.29
0.66	0.0396	0.12	1.41	0.77	0.27
0.88	0.0528	0.12	1.21	0.67	0.24
1.1	0.066	0.12	1.00	0.56	0.22
1.32	0.0792	0.12	0.79	0.46	0.19
1.54	0.0924	0.12	0.59	0.35	0.17
1.76	0.1056	0.12	0.54	0.33	0.15
1.98	0.1188	0.12	0.49	0.30	0.12
2.2	0.132	0.12	0.44	0.28	0.10
2.42	0.1452	0.12	0.40	0.25	0.07
2.64	0.1584	0.12	0.35	0.23	0.05
2.86	0.1716	0.12	0.30	0.20	0.02
3.08	0.1848	0.12	0.25	0.18	0.00
3.3	0.198	0.12	0.25	0.18	0.00
3.52	0.2112	0.12	0.24	0.17	0.00
3.74	0.2244	0.12	0.24	0.17	0.00
3.96	0.2376	0.12	0.23	0.16	0.00
4.18	0.2508	0.12	0.22	0.16	0.00
4.4	0.264	0.12	0.22	0.15	0.00
4.62	0.2772	0.12	0.21	0.15	0.00
4.84	0.2904	0.12	0.21	0.14	0.00
5.06	0.3036	0.12	0.20	0.14	0.00
5.28	0.3168	0.12	0.20	0.14	0.00
5.5	0.33	0.12	0.19	0.13	0.00
5.72	0.3432	0.12	0.18	0.13	0.00
5.94	0.3564	0.12	0.18	0.12	0.00
6.16	0.3696	0.12	0.17	0.12	0.00
6.38	0.3828	0.12	0.17	0.11	0.00
6.6	0.396	0.12	0.16	0.11	0.00
6.82	0.4092	0.12	0.16	0.10	0.00
7.04	0.4224	0.12	0.15	0.10	0.00
7.26	0.4356	0.12	0.14	0.10	0.00
7.48	0.4488	0.12	0.14	0.09	0.00
7.7	0.462	0.12	0.13	0.09	0.00
7.92	0.4752	0.12	0.13	0.08	0.00
8.14	0.4884	0.12	0.12	0.08	0.00
8.36	0.5016	0.12	0.12	0.07	0.00
8.58	0.5148	0.12	0.11	0.07	0.00
8.8	0.528	0.12	0.10	0.06	0.00
9.02	0.5412	0.12	0.10	0.06	0.00
9.24	0.5544	0.12	0.09	0.06	0.00
9.46	0.5676	0.12	0.09	0.05	0.00
9.68	0.5808	0.12	0.08	0.05	0.00
9.9	0.594	0.12	0.07	0.04	0.00
10.12	0.6072	0.12	0.07	0.04	0.00
10.34	0.6204	0.12	0.06	0.03	0.00
10.56	0.6336	0.12	0.06	0.03	0.00
10.78	0.6468	0.12	0.05	0.02	0.00
11	0.66	0.12	0.05	0.02	0.00

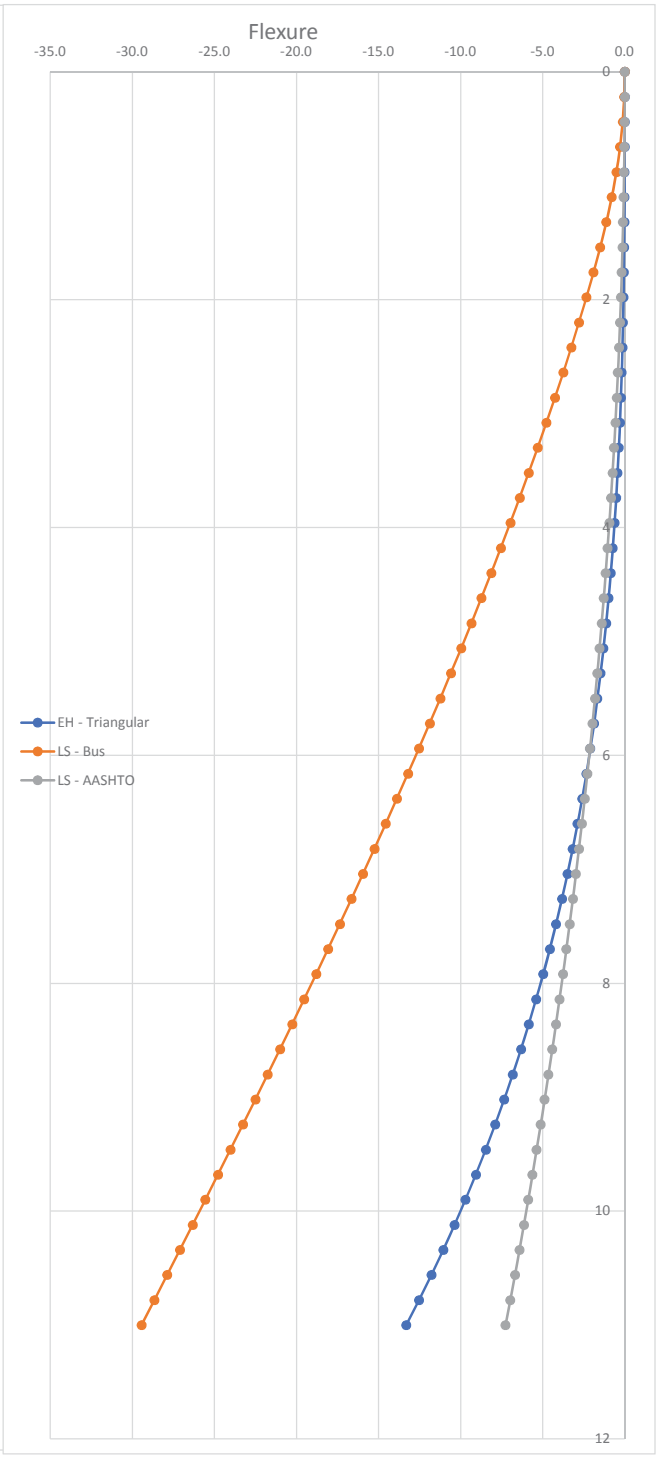


Cantilever H = 11 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0	0.0	-0.03	0.00	-0.28	-0.03	-0.17	-0.02	-0.07	-0.01
0.0	0.0	-0.05	-0.01	-0.57	-0.12	-0.34	-0.07	-0.14	-0.03
0.0	0.0	-0.08	-0.03	-0.87	-0.28	-0.51	-0.17	-0.20	-0.07
0.0	0.0	-0.11	-0.05	-1.17	-0.50	-0.67	-0.30	-0.26	-0.12
0.0	0.0	-0.13	-0.07	-1.42	-0.79	-0.81	-0.46	-0.31	-0.18
-0.1	0.0	-0.16	-0.10	-1.62	-1.12	-0.93	-0.65	-0.35	-0.25
-0.1	0.0	-0.18	-0.14	-1.77	-1.50	-1.01	-0.87	-0.39	-0.34
-0.1	-0.1	-0.21	-0.19	-1.89	-1.90	-1.08	-1.10	-0.43	-0.43
-0.1	-0.1	-0.24	-0.24	-2.00	-2.33	-1.15	-1.34	-0.46	-0.52
-0.1	-0.1	-0.26	-0.29	-2.10	-2.78	-1.21	-1.60	-0.48	-0.63
-0.2	-0.1	-0.29	-0.35	-2.19	-3.25	-1.27	-1.88	-0.50	-0.74
-0.2	-0.2	-0.32	-0.42	-2.27	-3.74	-1.32	-2.16	-0.52	-0.85
-0.2	-0.2	-0.34	-0.49	-2.33	-4.25	-1.37	-2.46	-0.52	-0.96
-0.3	-0.3	-0.37	-0.57	-2.39	-4.77	-1.41	-2.77	-0.53	-1.08
-0.3	-0.4	-0.40	-0.65	-2.45	-5.30	-1.45	-3.08	-0.53	-1.19
-0.4	-0.4	-0.42	-0.74	-2.50	-5.84	-1.49	-3.40	-0.53	-1.31
-0.4	-0.5	-0.45	-0.84	-2.55	-6.40	-1.52	-3.73	-0.53	-1.43
-0.5	-0.6	-0.48	-0.94	-2.60	-6.96	-1.56	-4.07	-0.53	-1.54
-0.5	-0.7	-0.50	-1.05	-2.65	-7.54	-1.59	-4.42	-0.53	-1.66
-0.6	-0.9	-0.53	-1.16	-2.70	-8.13	-1.63	-4.77	-0.53	-1.77
-0.6	-1.0	-0.55	-1.28	-2.75	-8.73	-1.66	-5.14	-0.53	-1.89
-0.7	-1.1	-0.58	-1.41	-2.79	-9.34	-1.69	-5.50	-0.53	-2.01
-0.8	-1.3	-0.61	-1.54	-2.84	-9.96	-1.72	-5.88	-0.53	-2.12
-0.8	-1.5	-0.63	-1.67	-2.88	-10.59	-1.75	-6.26	-0.53	-2.24
-0.9	-1.7	-0.66	-1.82	-2.92	-11.23	-1.78	-6.65	-0.53	-2.35
-1.0	-1.9	-0.69	-1.96	-2.96	-11.88	-1.81	-7.05	-0.53	-2.47
-1.1	-2.1	-0.71	-2.12	-3.00	-12.53	-1.84	-7.45	-0.53	-2.59
-1.1	-2.3	-0.74	-2.28	-3.04	-13.20	-1.86	-7.85	-0.53	-2.70
-1.2	-2.6	-0.77	-2.44	-3.08	-13.87	-1.89	-8.27	-0.53	-2.82
-1.3	-2.9	-0.79	-2.61	-3.11	-14.55	-1.91	-8.69	-0.53	-2.93
-1.4	-3.2	-0.82	-2.79	-3.15	-15.24	-1.94	-9.11	-0.53	-3.05
-1.5	-3.5	-0.84	-2.97	-3.18	-15.94	-1.96	-9.54	-0.53	-3.17
-1.6	-3.8	-0.87	-3.16	-3.21	-16.64	-1.98	-9.97	-0.53	-3.28
-1.7	-4.2	-0.90	-3.36	-3.25	-17.35	-2.00	-10.41	-0.53	-3.40
-1.8	-4.6	-0.92	-3.56	-3.27	-18.07	-2.02	-10.85	-0.53	-3.51
-1.9	-5.0	-0.95	-3.76	-3.30	-18.79	-2.04	-11.30	-0.53	-3.63
-2.0	-5.4	-0.98	-3.98	-3.33	-19.52	-2.06	-11.75	-0.53	-3.75
-2.1	-5.8	-1.00	-4.19	-3.36	-20.26	-2.07	-12.20	-0.53	-3.86
-2.2	-6.3	-1.03	-4.42	-3.38	-21.00	-2.09	-12.66	-0.53	-3.98
-2.3	-6.8	-1.06	-4.65	-3.40	-21.74	-2.10	-13.12	-0.53	-4.09
-2.4	-7.3	-1.08	-4.88	-3.43	-22.50	-2.12	-13.59	-0.53	-4.21
-2.6	-7.9	-1.11	-5.12	-3.45	-23.25	-2.13	-14.05	-0.53	-4.32
-2.7	-8.5	-1.14	-5.37	-3.47	-24.01	-2.14	-14.52	-0.53	-4.44
-2.8	-9.1	-1.16	-5.62	-3.48	-24.78	-2.15	-14.99	-0.53	-4.56
-2.9	-9.7	-1.19	-5.88	-3.50	-25.55	-2.16	-15.47	-0.53	-4.67
-3.1	-10.4	-1.21	-6.14	-3.52	-26.32	-2.17	-15.94	-0.53	-4.79
-3.2	-11.1	-1.24	-6.41	-3.53	-27.09	-2.18	-16.42	-0.53	-4.90
-3.3	-11.8	-1.27	-6.69	-3.54	-27.87	-2.18	-16.90	-0.53	-5.02
-3.5	-12.5	-1.29	-6.97	-3.56	-28.65	-2.19	-17.38	-0.53	-5.14
-3.6	-13.3	-1.32	-7.26	-3.57	-29.44	-2.20	-17.87	-0.53	-5.25
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.6	-13.3	-1.3	-7.3	-3.6	-29.4	-2.2	-17.9	-0.5	-5.3

Cantilever H = 11 ft

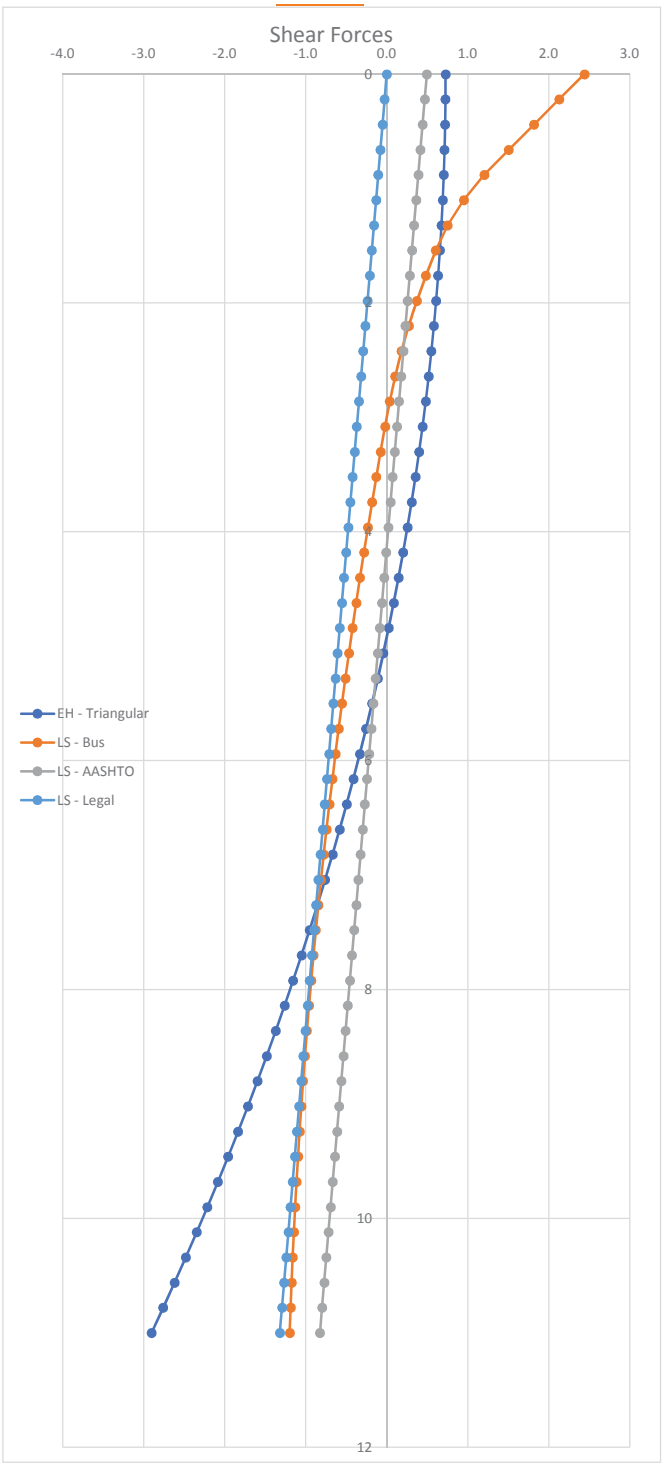


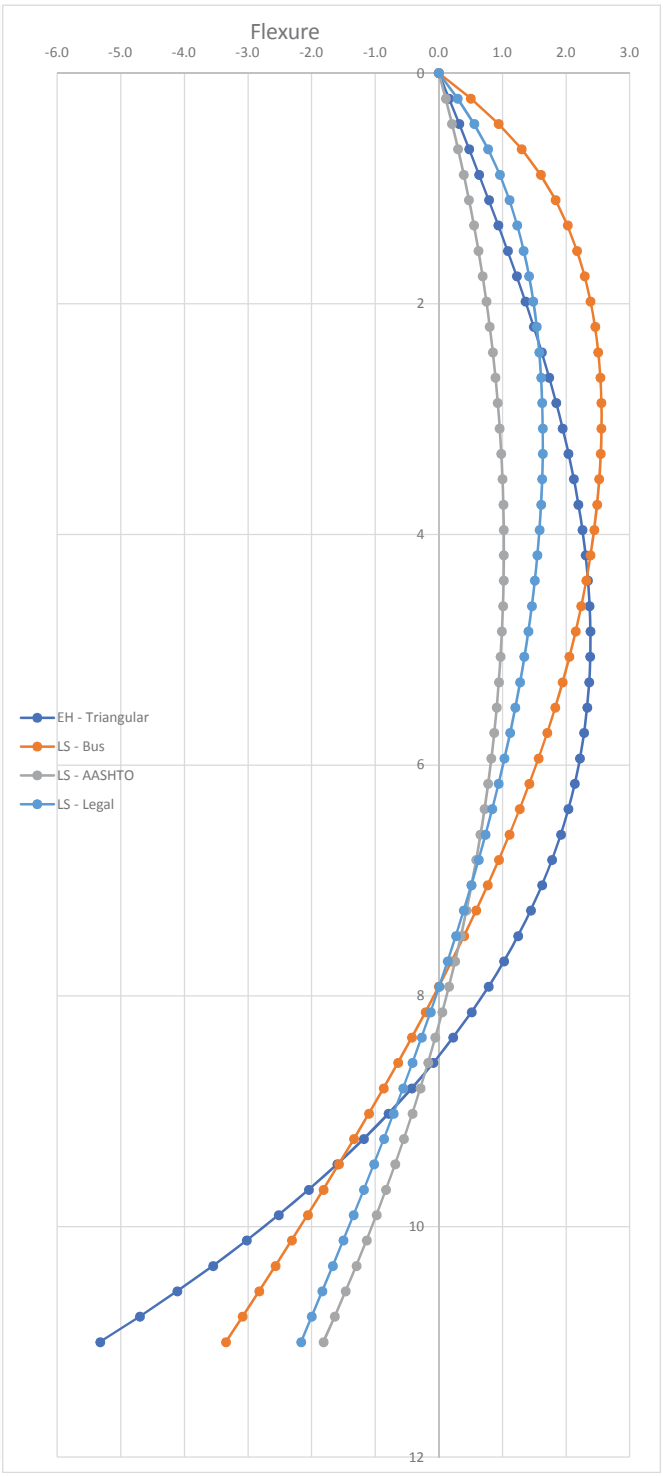


Pin Fix H = 11 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
0.7	0.0	0.50	0.00	2.44	0.00	1.43	0.00	0.45	0.00
0.7	0.2	0.47	0.11	2.13	0.50	1.26	0.30	0.38	0.09
0.7	0.3	0.44	0.21	1.82	0.94	1.09	0.55	0.31	0.17
0.7	0.5	0.42	0.30	1.51	1.30	0.92	0.77	0.25	0.23
0.7	0.6	0.39	0.39	1.20	1.60	0.75	0.96	0.20	0.28
0.7	0.8	0.36	0.47	0.95	1.84	0.61	1.11	0.15	0.32
0.7	0.9	0.34	0.55	0.75	2.02	0.50	1.23	0.10	0.34
0.7	1.1	0.31	0.62	0.61	2.17	0.42	1.33	0.06	0.36
0.6	1.2	0.28	0.69	0.48	2.29	0.34	1.41	0.02	0.37
0.6	1.4	0.26	0.74	0.37	2.38	0.27	1.48	0.00	0.37
0.6	1.5	0.23	0.80	0.27	2.45	0.21	1.54	-0.03	0.37
0.6	1.6	0.20	0.85	0.18	2.50	0.16	1.58	-0.05	0.36
0.5	1.7	0.18	0.89	0.10	2.54	0.10	1.60	-0.06	0.35
0.5	1.8	0.15	0.92	0.04	2.55	0.06	1.62	-0.07	0.33
0.4	1.9	0.13	0.96	-0.02	2.55	0.02	1.63	-0.07	0.32
0.4	2.0	0.10	0.98	-0.08	2.54	-0.02	1.63	-0.07	0.30
0.4	2.1	0.07	1.00	-0.13	2.52	-0.06	1.62	-0.07	0.29
0.3	2.2	0.05	1.01	-0.18	2.49	-0.10	1.60	-0.07	0.27
0.3	2.3	0.02	1.02	-0.23	2.44	-0.13	1.58	-0.07	0.25
0.2	2.3	-0.01	1.02	-0.28	2.38	-0.17	1.55	-0.07	0.24
0.1	2.3	-0.03	1.02	-0.33	2.32	-0.20	1.51	-0.07	0.22
0.1	2.4	-0.06	1.01	-0.38	2.24	-0.23	1.46	-0.07	0.20
0.0	2.4	-0.09	0.99	-0.42	2.15	-0.27	1.40	-0.07	0.19
0.0	2.4	-0.11	0.97	-0.47	2.05	-0.30	1.34	-0.07	0.17
-0.1	2.4	-0.14	0.94	-0.51	1.94	-0.33	1.27	-0.07	0.16
-0.2	2.3	-0.17	0.91	-0.55	1.83	-0.36	1.20	-0.07	0.14
-0.3	2.3	-0.19	0.87	-0.59	1.70	-0.38	1.12	-0.07	0.12
-0.3	2.2	-0.22	0.82	-0.63	1.57	-0.41	1.03	-0.07	0.11
-0.4	2.1	-0.24	0.77	-0.67	1.42	-0.44	0.94	-0.07	0.09
-0.5	2.0	-0.27	0.72	-0.71	1.27	-0.46	0.84	-0.07	0.07
-0.6	1.9	-0.30	0.65	-0.74	1.11	-0.49	0.73	-0.07	0.06
-0.7	1.8	-0.32	0.59	-0.78	0.94	-0.51	0.62	-0.07	0.04
-0.8	1.6	-0.35	0.51	-0.81	0.77	-0.53	0.51	-0.07	0.03
-0.9	1.4	-0.38	0.43	-0.84	0.59	-0.55	0.39	-0.07	0.01
-1.0	1.2	-0.40	0.35	-0.88	0.40	-0.57	0.27	-0.07	-0.01
-1.1	1.0	-0.43	0.25	-0.90	0.20	-0.59	0.14	-0.07	-0.02
-1.2	0.8	-0.46	0.16	-0.93	0.00	-0.61	0.01	-0.07	-0.04
-1.3	0.5	-0.48	0.05	-0.96	-0.21	-0.63	-0.13	-0.07	-0.06
-1.4	0.2	-0.51	-0.06	-0.99	-0.42	-0.65	-0.27	-0.07	-0.07
-1.5	-0.1	-0.53	-0.17	-1.01	-0.64	-0.66	-0.41	-0.07	-0.09
-1.6	-0.4	-0.56	-0.29	-1.03	-0.87	-0.68	-0.56	-0.07	-0.10
-1.7	-0.8	-0.59	-0.42	-1.06	-1.10	-0.69	-0.71	-0.07	-0.12
-1.8	-1.2	-0.61	-0.55	-1.08	-1.33	-0.70	-0.86	-0.07	-0.14
-2.0	-1.6	-0.64	-0.69	-1.10	-1.57	-0.71	-1.02	-0.07	-0.15
-2.1	-2.0	-0.67	-0.83	-1.11	-1.81	-0.72	-1.18	-0.07	-0.17
-2.2	-2.5	-0.69	-0.98	-1.13	-2.06	-0.73	-1.34	-0.07	-0.18
-2.3	-3.0	-0.72	-1.14	-1.15	-2.31	-0.74	-1.50	-0.07	-0.20
-2.5	-3.5	-0.75	-1.30	-1.16	-2.57	-0.75	-1.66	-0.07	-0.22
-2.6	-4.1	-0.77	-1.46	-1.17	-2.82	-0.76	-1.83	-0.07	-0.23
-2.8	-4.7	-0.80	-1.64	-1.19	-3.08	-0.76	-2.00	-0.07	-0.25
-2.9	-5.3	-0.83	-1.82	-1.20	-3.34	-0.77	-2.17	-0.07	-0.27
0.7	2.4	0.5	1.0	2.4	2.6	1.4	1.6	0.5	0.4
-2.9	-5.3	-0.8	-1.8	-1.2	-3.3	-0.8	-2.2	-0.1	-0.3

Pin Fix H = 11 ft



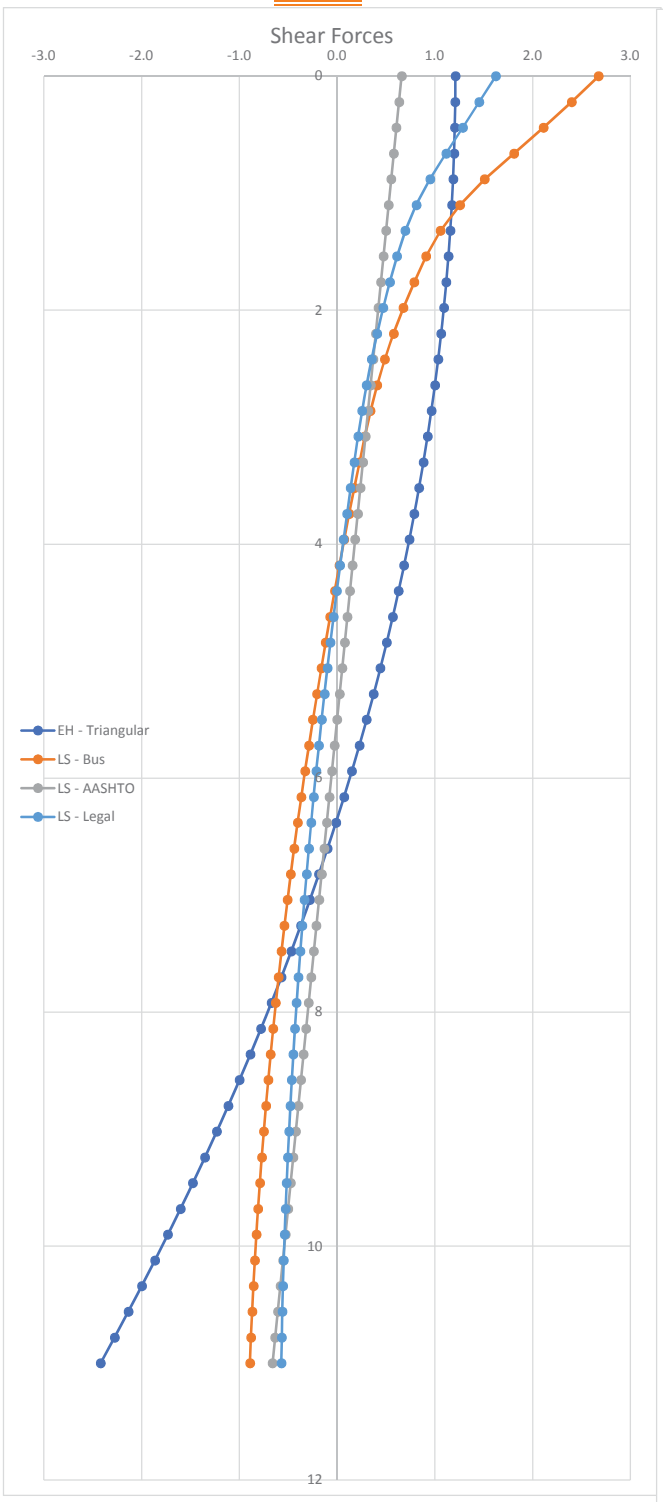


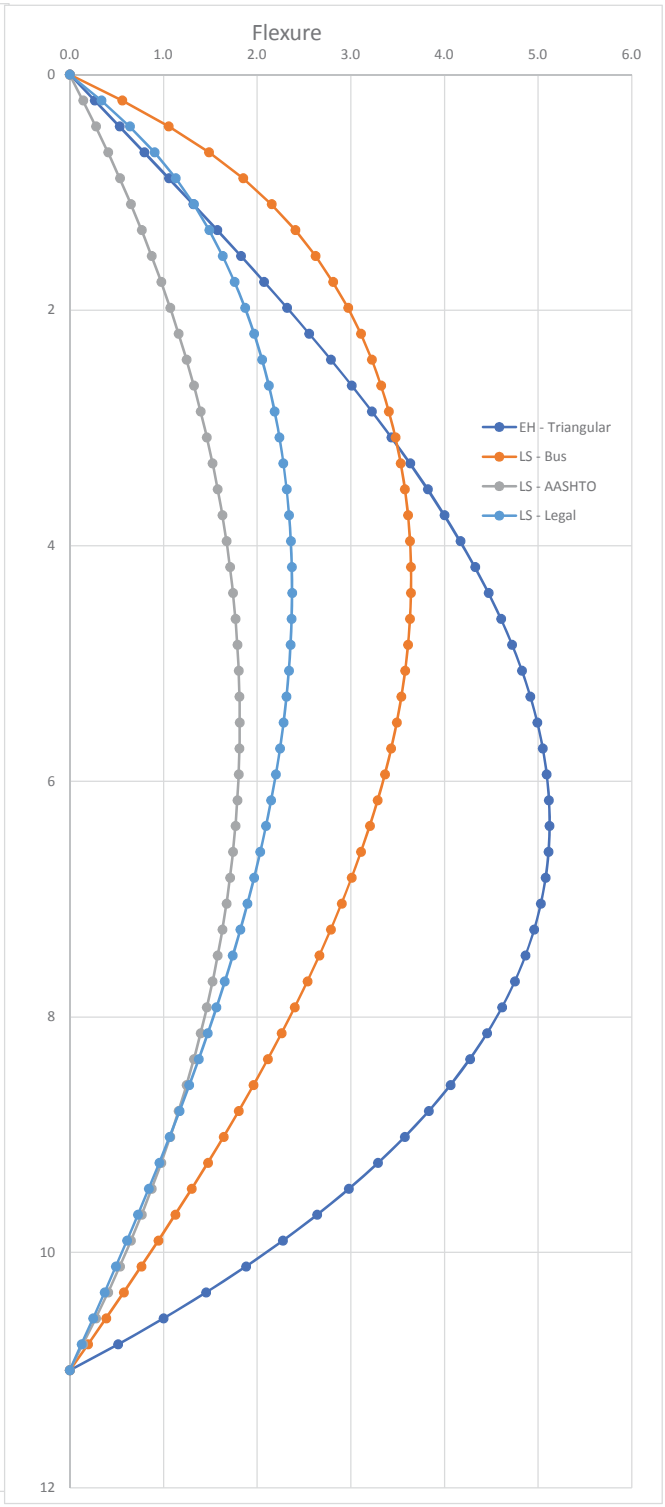
Pin-Pin H = 11 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
1.2	0.0	0.66	0.00	2.68	0.00	1.62	0.00	0.48	0.00
1.2	0.3	0.63	0.14	2.40	0.56	1.45	0.34	0.41	0.10
1.2	0.5	0.61	0.28	2.11	1.05	1.29	0.64	0.34	0.18
1.2	0.8	0.58	0.41	1.81	1.49	1.12	0.90	0.28	0.25
1.2	1.1	0.55	0.53	1.51	1.85	0.95	1.13	0.22	0.30
1.2	1.3	0.53	0.65	1.26	2.15	0.81	1.32	0.17	0.34
1.2	1.6	0.50	0.77	1.06	2.41	0.70	1.49	0.12	0.38
1.1	1.8	0.48	0.87	0.91	2.62	0.61	1.63	0.08	0.40
1.1	2.1	0.45	0.98	0.79	2.81	0.54	1.76	0.05	0.41
1.1	2.3	0.42	1.07	0.68	2.97	0.47	1.87	0.02	0.42
1.1	2.6	0.40	1.16	0.58	3.11	0.41	1.97	-0.01	0.42
1.0	2.8	0.37	1.25	0.49	3.23	0.35	2.05	-0.02	0.42
1.0	3.0	0.34	1.32	0.41	3.33	0.30	2.12	-0.04	0.41
1.0	3.2	0.32	1.40	0.34	3.41	0.26	2.19	-0.05	0.40
0.9	3.4	0.29	1.46	0.28	3.48	0.21	2.24	-0.05	0.39
0.9	3.6	0.26	1.52	0.23	3.53	0.18	2.28	-0.05	0.38
0.8	3.8	0.24	1.58	0.18	3.58	0.14	2.31	-0.05	0.37
0.8	4.0	0.21	1.63	0.12	3.61	0.10	2.34	-0.05	0.36
0.7	4.2	0.18	1.67	0.07	3.63	0.07	2.36	-0.05	0.35
0.7	4.3	0.16	1.71	0.02	3.64	0.03	2.37	-0.05	0.34
0.6	4.5	0.13	1.74	-0.02	3.64	0.00	2.37	-0.05	0.33
0.6	4.6	0.11	1.77	-0.07	3.63	-0.04	2.37	-0.05	0.32
0.5	4.7	0.08	1.79	-0.12	3.61	-0.07	2.36	-0.05	0.30
0.4	4.8	0.05	1.80	-0.16	3.58	-0.10	2.34	-0.05	0.29
0.4	4.9	0.03	1.81	-0.21	3.54	-0.13	2.31	-0.05	0.28
0.3	5.0	0.00	1.82	-0.25	3.49	-0.16	2.28	-0.05	0.27
0.2	5.0	-0.03	1.81	-0.29	3.43	-0.19	2.24	-0.05	0.26
0.2	5.1	-0.05	1.80	-0.33	3.36	-0.21	2.20	-0.05	0.25
0.1	5.1	-0.08	1.79	-0.37	3.29	-0.24	2.15	-0.05	0.24
0.0	5.1	-0.11	1.77	-0.40	3.20	-0.26	2.09	-0.05	0.23
-0.1	5.1	-0.13	1.74	-0.44	3.11	-0.29	2.03	-0.05	0.22
-0.2	5.1	-0.16	1.71	-0.47	3.01	-0.31	1.97	-0.05	0.21
-0.3	5.0	-0.18	1.67	-0.51	2.90	-0.33	1.90	-0.05	0.20
-0.4	5.0	-0.21	1.63	-0.54	2.79	-0.36	1.82	-0.05	0.19
-0.5	4.9	-0.24	1.58	-0.57	2.67	-0.38	1.74	-0.05	0.17
-0.6	4.8	-0.26	1.52	-0.60	2.54	-0.40	1.65	-0.05	0.16
-0.7	4.6	-0.29	1.46	-0.63	2.40	-0.41	1.57	-0.05	0.15
-0.8	4.5	-0.32	1.40	-0.65	2.26	-0.43	1.47	-0.05	0.14
-0.9	4.3	-0.34	1.32	-0.68	2.11	-0.45	1.38	-0.05	0.13
-1.0	4.1	-0.37	1.25	-0.70	1.96	-0.46	1.28	-0.05	0.12
-1.1	3.8	-0.40	1.16	-0.73	1.80	-0.48	1.17	-0.05	0.11
-1.2	3.6	-0.42	1.07	-0.75	1.64	-0.49	1.07	-0.05	0.10
-1.4	3.3	-0.45	0.98	-0.77	1.47	-0.50	0.96	-0.05	0.09
-1.5	3.0	-0.48	0.87	-0.79	1.30	-0.52	0.84	-0.05	0.08
-1.6	2.6	-0.50	0.77	-0.81	1.13	-0.53	0.73	-0.05	0.07
-1.7	2.3	-0.53	0.65	-0.83	0.95	-0.54	0.61	-0.05	0.05
-1.9	1.9	-0.55	0.53	-0.84	0.76	-0.55	0.49	-0.05	0.04
-2.0	1.5	-0.58	0.41	-0.86	0.58	-0.55	0.37	-0.05	0.03
-2.1	1.0	-0.61	0.28	-0.87	0.39	-0.56	0.25	-0.05	0.02
-2.3	0.5	-0.63	0.14	-0.88	0.20	-0.57	0.13	-0.05	0.01
-2.4	0.0	-0.66	0.00	-0.89	0.00	-0.57	0.00	-0.05	0.00
1.2	5.1	0.7	1.8	2.7	3.6	1.6	2.4	0.5	0.4
-2.4	0.0	-0.7	0.0	-0.9	0.0	-0.6	0.0	0.0	0.0

	EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
	V	M	V	M	V	M	V	M	V	M
Pin Fix	2.90	5.32	0.83	1.82	2.44	3.34	1.43	2.17	0.45	0.37
Pin-Pin	2.42	5.12	0.66	1.82	2.68	3.64	1.62	2.37	0.48	0.42
Max	**2.90**	**5.32**	**0.83**	**1.82**	**2.68**	**3.64**	**1.62**	**2.37**	**0.48**	**0.42**

Pin-Pin H = 11 ft





Loading Analysis

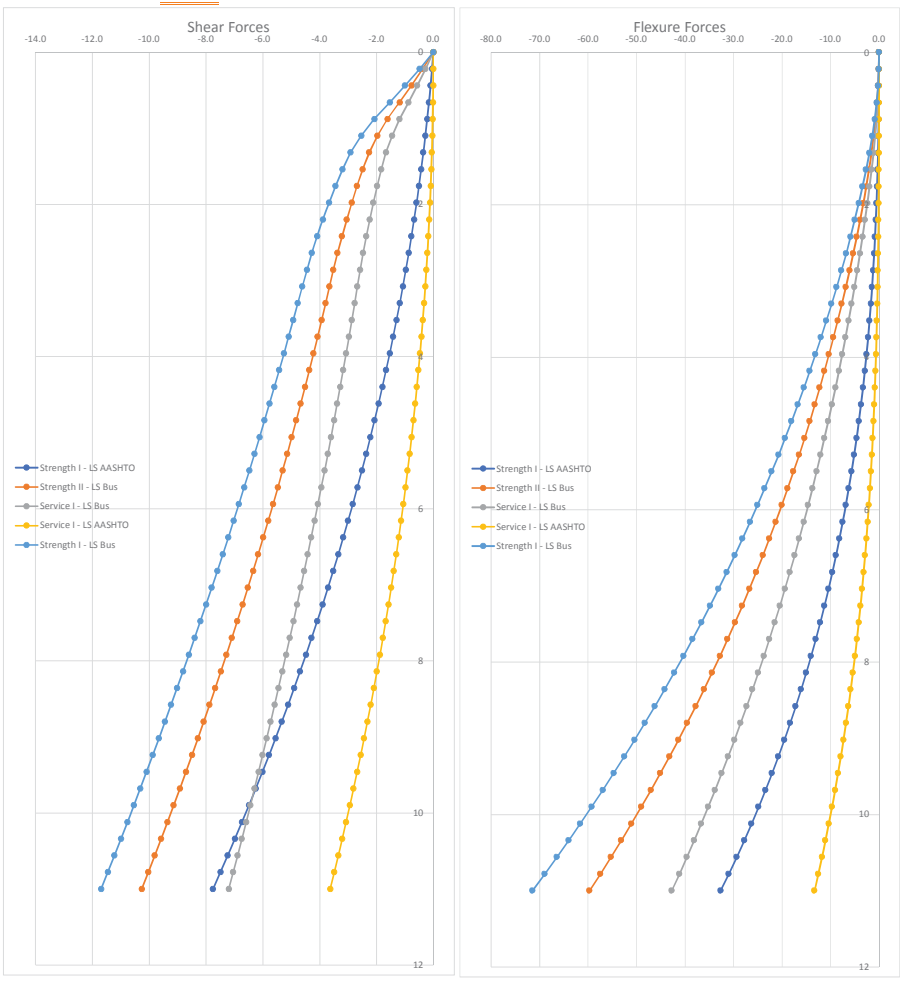
Load Combinations

	EH	LS
Strength I	1.35	1.75
Strength II	1.35	1.35
Service I	1	1

Cantilever H = 11 ft

H	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal	
	V	M	V	M			V	M	V	M	V	M	V	M
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00		
0.22	0.0	0.0	-0.5	-0.1	-0.2	0.0	-0.4	0.0	0.00	0.00	-0.28	-0.03		
0.44	-0.1	0.0	-1.0	-0.2	-0.5	-0.1	-0.8	-0.2	-0.01	0.00	-0.57	-0.12		
0.66	-0.2	-0.1	-1.5	-0.5	-0.7	-0.2	-1.2	-0.4	-0.01	0.00	-0.88	-0.28		
0.88	-0.2	-0.1	-2.1	-0.9	-0.9	-0.4	-1.6	-0.7	-0.02	-0.01	-1.19	-0.51		
1.1	-0.3	-0.1	-2.5	-1.4	-1.2	-0.6	-2.0	-1.1	-0.04	-0.01	-1.46	-0.80		
1.32	-0.4	-0.2	-2.9	-2.0	-1.3	-0.9	-2.3	-1.6	-0.05	-0.02	-1.67	-1.15		
1.54	-0.4	-0.3	-3.2	-2.7	-1.5	-1.2	-2.5	-2.1	-0.07	-0.04	-1.84	-1.53		
1.76	-0.5	-0.4	-3.4	-3.4	-1.6	-1.6	-2.7	-2.6	-0.09	-0.05	-1.98	-1.95		
1.98	-0.6	-0.5	-3.7	-4.2	-1.7	-1.9	-2.9	-3.3	-0.12	-0.08	-2.12	-2.40		
2.2	-0.7	-0.7	-3.9	-5.0	-1.9	-2.3	-3.1	-3.9	-0.15	-0.11	-2.24	-2.88		
2.42	-0.8	-0.8	-4.1	-5.9	-2.0	-2.7	-3.2	-4.6	-0.18	-0.14	-2.36	-3.39		
2.64	-0.9	-1.0	-4.3	-6.8	-2.1	-3.2	-3.4	-5.3	-0.21	-0.18	-2.48	-3.92		
2.86	-1.0	-1.2	-4.5	-7.8	-2.2	-3.7	-3.5	-6.1	-0.25	-0.23	-2.58	-4.48		
3.08	-1.1	-1.4	-4.6	-8.8	-2.3	-4.2	-3.7	-6.9	-0.28	-0.29	-2.68	-5.06		
3.3	-1.2	-1.7	-4.8	-9.8	-2.4	-4.7	-3.8	-7.7	-0.33	-0.36	-2.77	-5.66		
3.52	-1.3	-2.0	-4.9	-10.9	-2.6	-5.2	-3.9	-8.5	-0.37	-0.44	-2.87	-6.28		
3.74	-1.4	-2.3	-5.1	-12.0	-2.7	-5.8	-4.1	-9.4	-0.42	-0.52	-2.97	-6.92		
3.96	-1.5	-2.6	-5.3	-13.1	-2.8	-6.4	-4.2	-10.3	-0.47	-0.62	-3.07	-7.59		
4.18	-1.7	-2.9	-5.4	-14.3	-2.9	-7.1	-4.4	-11.3	-0.52	-0.73	-3.18	-8.27		
4.4	-1.8	-3.3	-5.6	-15.5	-3.1	-7.7	-4.5	-12.3	-0.58	-0.85	-3.28	-8.98		
4.62	-1.9	-3.7	-5.8	-16.8	-3.2	-8.4	-4.7	-13.3	-0.64	-0.99	-3.39	-9.72		
4.84	-2.1	-4.2	-5.9	-18.0	-3.3	-9.1	-4.8	-14.3	-0.70	-1.13	-3.50	-10.47		
5.06	-2.2	-4.6	-6.1	-19.4	-3.5	-9.9	-5.0	-15.4	-0.77	-1.30	-3.61	-11.26		
5.28	-2.4	-5.1	-6.3	-20.7	-3.6	-10.7	-5.1	-16.5	-0.84	-1.47	-3.72	-12.06		
5.5	-2.5	-5.7	-6.5	-22.1	-3.8	-11.5	-5.3	-17.7	-0.91	-1.66	-3.83	-12.89		
5.72	-2.7	-6.2	-6.7	-23.6	-3.9	-12.3	-5.5	-18.8	-0.98	-1.87	-3.95	-13.75		
5.94	-2.8	-6.8	-6.8	-25.1	-4.1	-13.2	-5.6	-20.1	-1.06	-2.10	-4.06	-14.63		
6.16	-3.0	-7.5	-7.0	-26.6	-4.2	-14.1	-5.8	-21.3	-1.14	-2.34	-4.18	-15.53		
6.38	-3.2	-8.2	-7.2	-28.2	-4.4	-15.1	-6.0	-22.6	-1.22	-2.60	-4.30	-16.47		
6.6	-3.3	-8.9	-7.4	-29.8	-4.5	-16.0	-6.2	-24.0	-1.31	-2.87	-4.42	-17.43		
6.82	-3.5	-9.6	-7.6	-31.4	-4.7	-17.1	-6.3	-25.3	-1.40	-3.17	-4.54	-18.41		
7.04	-3.7	-10.4	-7.8	-33.1	-4.9	-18.1	-6.5	-26.7	-1.49	-3.49	-4.67	-19.43		
7.26	-3.9	-11.3	-8.0	-34.9	-5.0	-19.2	-6.7	-28.2	-1.58	-3.83	-4.80	-20.47		
7.48	-4.1	-12.2	-8.2	-36.6	-5.2	-20.3	-6.9	-29.7	-1.68	-4.19	-4.92	-21.54		
7.7	-4.3	-13.1	-8.4	-38.5	-5.4	-21.5	-7.1	-31.2	-1.78	-4.57	-5.05	-22.63		
7.92	-4.5	-14.0	-8.6	-40.3	-5.6	-22.7	-7.3	-32.8	-1.88	-4.97	-5.19	-23.76		
8.14	-4.7	-15.0	-8.8	-42.3	-5.8	-24.0	-7.5	-34.4	-1.99	-5.39	-5.32	-24.92		
8.36	-4.9	-16.1	-9.0	-44.2	-5.9	-25.2	-7.7	-36.1	-2.10	-5.84	-5.45	-26.10		
8.58	-5.1	-17.2	-9.2	-46.2	-6.1	-26.6	-7.9	-37.8	-2.21	-6.32	-5.59	-27.31		
8.8	-5.3	-18.4	-9.4	-48.3	-6.3	-27.9	-8.1	-39.6	-2.32	-6.81	-5.73	-28.56		
9.02	-5.6	-19.6	-9.7	-50.4	-6.5	-29.3	-8.3	-41.4	-2.44	-7.34	-5.87	-29.83		
9.24	-5.8	-20.8	-9.9	-52.5	-6.7	-30.8	-8.5	-43.2	-2.56	-7.89	-6.01	-31.14		
9.46	-6.0	-22.1	-10.1	-54.7	-6.9	-32.3	-8.7	-45.1	-2.68	-8.47	-6.15	-32.48		
9.68	-6.2	-23.4	-10.3	-57.0	-7.1	-33.8	-8.9	-47.1	-2.81	-9.07	-6.30	-33.85		
9.9	-6.5	-24.8	-10.5	-59.3	-7.3	-35.4	-9.1	-49.0	-2.94	-9.70	-6.44	-35.25		
10.12	-6.7	-26.3	-10.8	-61.6	-7.5	-37.1	-9.4	-51.1	-3.07	-10.36	-6.59	-36.68		
10.34	-7.0	-27.8	-11.0	-64.0	-7.8	-38.8	-9.6	-53.2	-3.21	-11.06	-6.74	-38.15		
10.56	-7.2	-29.4	-11.2	-66.4	-8.0	-40.5	-9.8	-55.3	-3.35	-11.78	-6.89	-39.65		
10.78	-7.5	-31.0	-11.5	-68.9	-8.2	-42.3	-10.0	-57.5	-3.49	-12.53	-7.04	-41.18		
11	-7.8	-32.7	-11.7	-71.5	-8.4	-44.1	-10.3	-59.7	-3.63	-13.31	-7.20	-42.75		
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	-7.8	-32.7	-11.7	-71.5	-8.4	-44.1	-10.3	-59.7	-3.6	-13.3	-7.2	-42.7		

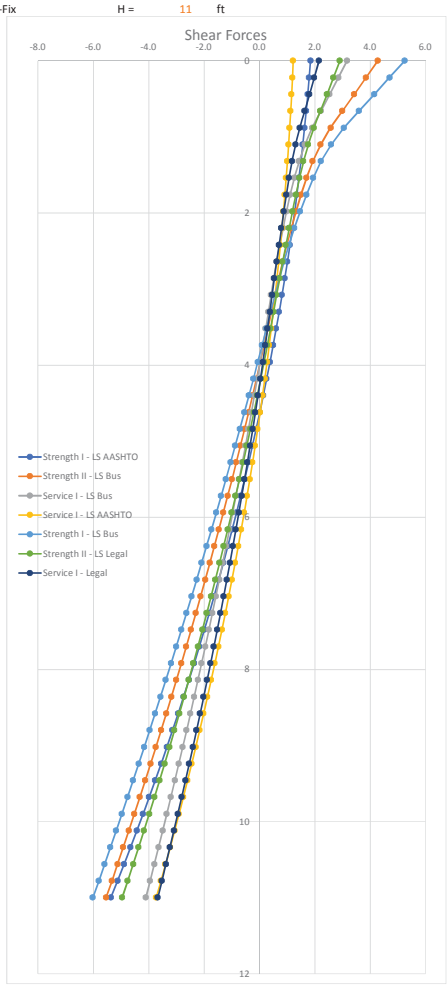
Cantilever H = 11 ft

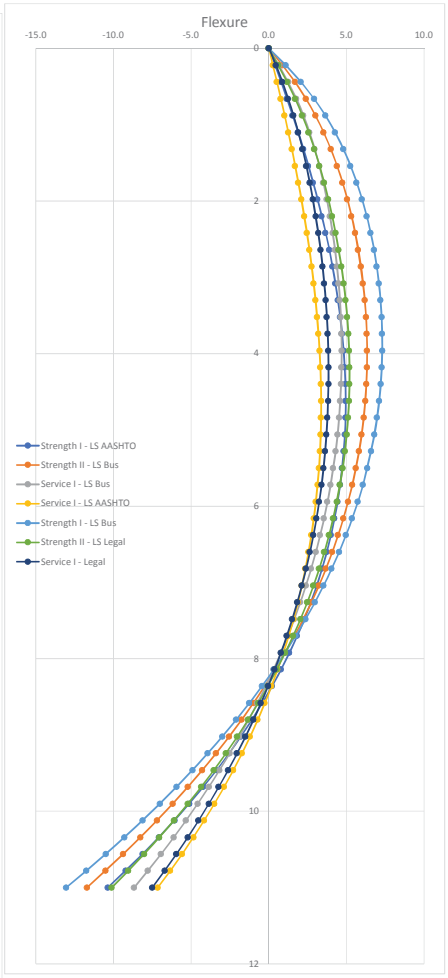


Pin Fix H = 11 ft

H	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal		Service I - Normal Traffic	
	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M
0	1.8	0.0	5.2	0.0	2.91	0.00	4.27	0.00	1.22	0.00	3.17	0.00	2.15	0.00	1.18	0.00
0.22	1.8	0.4	4.7	1.1	2.68	0.61	3.85	0.89	1.19	0.27	2.85	0.66	1.98	0.45	1.11	0.25
0.44	1.7	0.8	4.2	2.1	2.44	1.18	3.43	1.69	1.16	0.52	2.54	1.26	1.81	0.87	1.03	0.49
0.66	1.7	1.2	3.6	2.9	2.20	1.69	3.00	2.40	1.13	0.78	2.22	1.78	1.63	1.25	0.97	0.71
0.88	1.6	1.5	3.1	3.7	1.97	2.15	2.57	3.01	1.09	1.02	1.91	2.23	1.46	1.59	0.90	0.91
1.1	1.6	1.9	2.6	4.3	1.76	2.56	2.22	3.54	1.05	1.26	1.64	2.62	1.30	1.89	0.84	1.10
1.32	1.5	2.2	2.2	4.8	1.59	2.92	1.92	3.99	1.01	1.48	1.43	2.96	1.18	2.17	0.77	1.28
1.54	1.4	2.5	1.9	5.3	1.45	3.26	1.70	4.39	0.97	1.70	1.26	3.25	1.07	2.41	0.71	1.44
1.76	1.4	2.9	1.7	5.7	1.32	3.56	1.51	4.74	0.92	1.91	1.12	3.51	0.98	2.64	0.66	1.59
1.98	1.3	3.1	1.5	6.0	1.19	3.84	1.32	5.05	0.87	2.10	0.98	3.74	0.88	2.84	0.60	1.73
2.2	1.2	3.4	1.3	6.3	1.07	4.09	1.15	5.33	0.81	2.29	0.85	3.95	0.79	3.03	0.55	1.86
2.42	1.1	3.7	1.1	6.6	0.95	4.31	0.99	5.56	0.75	2.46	0.73	4.12	0.71	3.19	0.50	1.98
2.64	1.0	3.9	0.9	6.8	0.84	4.51	0.84	5.76	0.70	2.62	0.62	4.27	0.62	3.34	0.45	2.08
2.86	0.9	4.1	0.7	7.0	0.73	4.68	0.70	5.93	0.63	2.77	0.52	4.39	0.54	3.46	0.41	2.18
3.08	0.8	4.3	0.6	7.1	0.62	4.83	0.57	6.07	0.57	2.90	0.42	4.50	0.46	3.57	0.37	2.26
3.3	0.7	4.5	0.4	7.2	0.51	4.95	0.44	6.18	0.50	3.02	0.32	4.58	0.38	3.67	0.33	2.34
3.52	0.6	4.6	0.3	7.3	0.40	5.05	0.30	6.26	0.43	3.12	0.22	4.64	0.30	3.74	0.28	2.40
3.74	0.5	4.7	0.1	7.3	0.28	5.13	0.17	6.31	0.35	3.20	0.12	4.68	0.21	3.80	0.23	2.46
3.96	0.4	4.8	-0.1	7.3	0.17	5.18	0.03	6.34	0.28	3.27	0.02	4.69	0.12	3.83	0.18	2.51
4.18	0.3	4.9	-0.2	7.3	0.05	5.20	-0.11	6.33	0.20	3.33	-0.08	4.69	0.04	3.85	0.13	2.54
4.4	0.1	4.9	-0.4	7.2	-0.07	5.20	-0.25	6.29	0.11	3.36	-0.18	4.66	-0.05	3.85	0.07	2.56
4.62	0.0	5.0	-0.5	7.1	-0.20	5.17	-0.39	6.22	0.03	3.37	-0.29	4.61	-0.15	3.83	0.01	2.57
4.84	-0.1	4.9	-0.7	7.0	-0.33	5.11	-0.54	6.12	-0.06	3.37	-0.40	4.53	-0.24	3.78	-0.05	2.57
5.06	-0.3	4.9	-0.9	6.8	-0.46	5.02	-0.69	5.98	-0.15	3.35	-0.51	4.43	-0.34	3.72	-0.12	2.55
5.28	-0.4	4.8	-1.0	6.6	-0.59	4.91	-0.84	5.81	-0.25	3.30	-0.62	4.31	-0.44	3.64	-0.18	2.52
5.5	-0.5	4.7	-1.2	6.3	-0.72	4.76	-0.99	5.61	-0.35	3.24	-0.73	4.16	-0.54	3.53	-0.26	2.47
5.72	-0.7	4.6	-1.4	6.1	-0.86	4.59	-1.15	5.38	-0.45	3.15	-0.85	3.98	-0.64	3.40	-0.33	2.40
5.94	-0.8	4.4	-1.6	5.7	-1.00	4.38	-1.30	5.11	-0.55	3.04	-0.97	3.78	-0.74	3.25	-0.41	2.32
6.16	-1.0	4.2	-1.7	5.4	-1.15	4.15	-1.46	4.80	-0.66	2.91	-1.08	3.56	-0.85	3.07	-0.49	2.23
6.38	-1.1	4.0	-1.9	5.0	-1.29	3.88	-1.63	4.46	-0.77	2.75	-1.20	3.31	-0.96	2.87	-0.57	2.11
6.6	-1.3	3.7	-2.1	4.5	-1.44	3.58	-1.79	4.09	-0.88	2.57	-1.33	3.03	-1.07	2.65	-0.65	1.97
6.82	-1.5	3.4	-2.3	4.1	-1.59	3.25	-1.96	3.68	-0.99	2.36	-1.45	2.72	-1.18	2.40	-0.74	1.82
7.04	-1.6	3.1	-2.4	3.5	-1.74	2.88	-2.12	3.23	-1.11	2.13	-1.57	2.39	-1.29	2.13	-0.83	1.65
7.26	-1.8	2.7	-2.6	3.0	-1.90	2.48	-2.29	2.74	-1.23	1.88	-1.70	2.03	-1.41	1.84	-0.93	1.45
7.48	-2.0	2.3	-2.8	2.4	-2.06	2.04	-2.47	2.22	-1.36	1.59	-1.83	1.64	-1.53	1.51	-1.03	1.24
7.7	-2.2	1.8	-3.0	1.7	-2.22	1.57	-2.64	1.65	-1.48	1.28	-1.96	1.23	-1.65	1.16	-1.13	1.00
7.92	-2.4	1.3	-3.2	1.1	-2.39	1.06	-2.82	1.05	-1.61	0.94	-2.09	0.78	-1.77	0.79	-1.23	0.74
8.14	-2.5	0.8	-3.4	0.3	-2.55	0.52	-3.00	0.41	-1.74	0.57	-2.22	0.31	-1.89	0.39	-1.34	0.46
8.36	-2.7	0.2	-3.6	-0.4	-2.72	-0.06	-3.18	-0.27	-1.88	0.17	-2.36	-0.20	-2.02	-0.04	-1.44	0.16
8.58	-2.9	-0.4	-3.8	-1.2	-2.89	-0.68	-3.37	-0.99	-2.02	-0.26	-2.49	-0.73	-2.14	-0.50	-1.56	-0.17
8.8	-3.1	-1.1	-4.0	-2.1	-3.07	-1.33	-3.55	-1.75	-2.16	-0.72	-2.63	-1.29	-2.27	-0.99	-1.67	-0.53
9.02	-3.3	-1.8	-4.2	-3.0	-3.24	-2.03	-3.74	-2.55	-2.30	-1.21	-2.77	-1.89	-2.40	-1.50	-1.79	-0.91
9.24	-3.6	-2.6	-4.4	-3.9	-3.42	-2.76	-3.93	-3.39	-2.45	-1.73	-2.91	-2.51	-2.54	-2.04	-1.91	-1.32
9.46	-3.8	-3.4	-4.6	-4.9	-3.61	-3.53	-4.12	-4.28	-2.60	-2.28	-3.05	-3.17	-2.67	-2.62	-2.03	-1.75
9.68	-4.0	-4.2	-4.8	-5.9	-3.79	-4.35	-4.32	-5.21	-2.75	-2.87	-3.20	-3.86	-2.81	-3.22	-2.16	-2.21
9.9	-4.2	-5.1	-5.0	-7.0	-3.98	-5.20	-4.52	-6.18	-2.91	-3.50	-3.35	-4.58	-2.95	-3.85	-2.29	-2.70
10.12	-4.4	-6.1	-5.2	-8.1	-4.17	-6.10	-4.72	-7.19	-3.07	-4.15	-3.49	-5.33	-3.09	-4.52	-2.42	-3.22
10.34	-4.7	-7.1	-5.4	-9.3	-4.36	-7.04	-4.92	-8.25	-3.23	-4.84	-3.64	-6.11	-3.23	-5.21	-2.56	-3.77
10.56	-4.9	-8.1	-5.6	-10.5	-4.56	-8.02	-5.12	-9.36	-3.39	-5.57	-3.79	-6.93	-3.38	-5.94	-2.69	-4.34
10.78	-5.1	-9.2	-5.8	-11.7	-4.76	-9.04	-5.33	-10.51	-3.56	-6.34	-3.95	-7.78	-3.52	-6.70	-2.83	-4.95
11	-5.4	-10.4	-6.0	-13.0	-4.96	-10.11	-5.54	-11.70	-3.73	-7.14	-4.10	-8.67	-3.67	-7.49	-2.98	-5.59
	1.8	5.0	5.2	7.3	2.9	5.2	4.3	6.3	1.2	3.4	3.2	4.7	2.2	3.9	1.2	2.6
	-5.4	-10.4	-6.0	-13.0	-5.0	-10.1	-5.5	-11.7	-3.7	-7.1	-4.1	-8.7	-3.7	-7.5	-3.0	-5.6

Pin-Fix H = 11 ft





Pin-Pin H = 11 ft

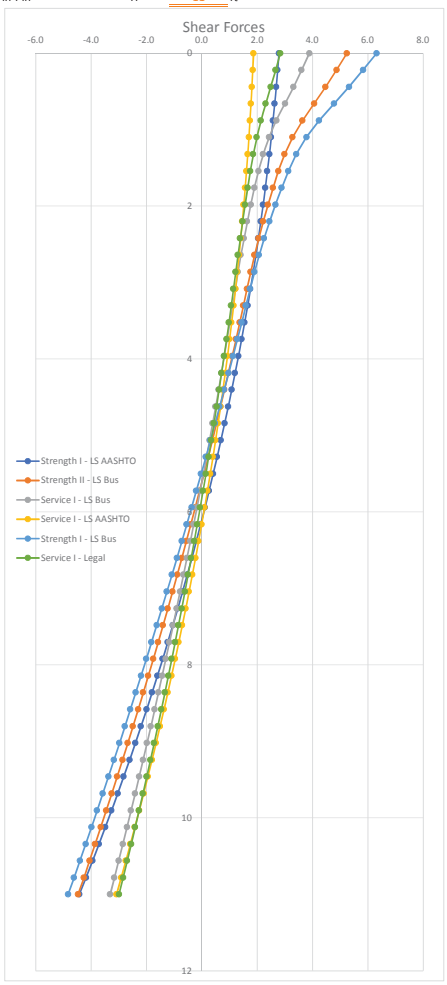
	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal	
H	V	M	V	M	V	M	V	M	V	M	V	M	V	M
0	2.8	0.0	6.3	0.0	3.83	0.00	5.2	0.0	1.87	0.00	3.89	0.00	2.83	0.00
0.22	2.7	0.6	5.8	1.3	3.60	0.82	4.9	1.1	1.84	0.41	3.61	0.82	2.66	0.60
0.44	2.7	1.2	5.3	2.6	3.36	1.58	4.5	2.1	1.81	0.81	3.32	1.59	2.49	1.17
0.66	2.6	1.8	4.8	3.7	3.12	2.30	4.1	3.1	1.78	1.21	3.01	2.28	2.31	1.70
0.88	2.6	2.4	4.2	4.7	2.89	2.96	3.6	3.9	1.74	1.59	2.70	2.91	2.14	2.19
1.1	2.5	2.9	3.8	5.5	2.68	3.57	3.3	4.7	1.70	1.97	2.43	3.47	1.99	2.64
1.32	2.4	3.5	3.4	6.3	2.51	4.14	3.0	5.4	1.66	2.34	2.22	3.98	1.86	3.06
1.54	2.4	4.0	3.1	7.1	2.36	4.67	2.8	6.0	1.61	2.70	2.05	4.45	1.75	3.46
1.76	2.3	4.5	2.9	7.7	2.24	5.18	2.6	6.6	1.57	3.05	1.91	4.89	1.66	3.84
1.98	2.2	5.0	2.7	8.3	2.11	5.66	2.4	7.1	1.51	3.39	1.77	5.29	1.56	4.19
2.2	2.1	5.5	2.4	8.9	1.99	6.11	2.2	7.6	1.46	3.72	1.64	5.67	1.47	4.52
2.42	2.0	5.9	2.3	9.4	1.87	6.53	2.1	8.1	1.40	4.03	1.52	6.01	1.39	4.84
2.64	2.0	6.4	2.1	9.9	1.76	6.93	1.9	8.6	1.34	4.33	1.41	6.34	1.30	5.13
2.86	1.9	6.8	1.9	10.3	1.65	7.31	1.8	9.0	1.28	4.62	1.31	6.63	1.22	5.41
3.08	1.8	7.2	1.7	10.7	1.54	7.66	1.6	9.3	1.22	4.90	1.21	6.91	1.14	5.67
3.3	1.7	7.6	1.6	11.1	1.43	7.98	1.5	9.7	1.15	5.16	1.11	7.17	1.06	5.91
3.52	1.5	7.9	1.4	11.4	1.32	8.29	1.4	10.0	1.08	5.40	1.01	7.40	0.98	6.14
3.74	1.4	8.3	1.3	11.7	1.20	8.56	1.2	10.3	1.00	5.63	0.91	7.61	0.89	6.34
3.96	1.3	8.6	1.1	12.0	1.09	8.82	1.1	10.5	0.92	5.84	0.81	7.80	0.81	6.53
4.18	1.2	8.8	1.0	12.2	0.97	9.04	1.0	10.8	0.84	6.04	0.71	7.97	0.72	6.70
4.4	1.1	9.1	0.8	12.4	0.85	9.24	0.8	11.0	0.76	6.21	0.60	8.12	0.63	6.85
4.62	1.0	9.3	0.6	12.6	0.72	9.41	0.7	11.1	0.68	6.37	0.50	8.24	0.53	6.97
4.84	0.8	9.5	0.5	12.7	0.59	9.56	0.5	11.3	0.59	6.51	0.39	8.33	0.44	7.08
5.06	0.7	9.7	0.3	12.8	0.46	9.67	0.4	11.4	0.49	6.63	0.28	8.41	0.34	7.17
5.28	0.6	9.8	0.1	12.8	0.33	9.76	0.2	11.4	0.40	6.73	0.17	8.46	0.24	7.23
5.5	0.4	9.9	0.0	12.8	0.19	9.82	0.1	11.5	0.30	6.81	0.06	8.48	0.14	7.27
5.72	0.3	10.0	-0.2	12.8	0.06	9.85	-0.1	11.5	0.20	6.86	-0.06	8.48	0.04	7.29
5.94	0.1	10.0	-0.4	12.8	-0.08	9.84	-0.2	11.4	0.10	6.89	-0.18	8.46	-0.06	7.29
6.16	0.0	10.0	-0.5	12.7	-0.23	9.81	-0.4	11.3	-0.01	6.91	-0.29	8.40	-0.17	7.27
6.38	-0.2	10.0	-0.7	12.5	-0.37	9.74	-0.6	11.2	-0.12	6.89	-0.41	8.33	-0.28	7.22
6.6	-0.4	9.9	-0.9	12.3	-0.52	9.65	-0.7	11.1	-0.23	6.85	-0.54	8.22	-0.39	7.14
6.82	-0.5	9.9	-1.1	12.1	-0.67	9.51	-0.9	10.9	-0.34	6.79	-0.66	8.09	-0.50	7.05
7.04	-0.7	9.7	-1.3	11.9	-0.83	9.35	-1.1	10.7	-0.46	6.70	-0.78	7.93	-0.61	6.93
7.26	-0.9	9.5	-1.4	11.6	-0.98	9.15	-1.2	10.5	-0.58	6.59	-0.91	7.75	-0.73	6.78
7.48	-1.0	9.3	-1.6	11.2	-1.14	8.92	-1.4	10.2	-0.71	6.45	-1.04	7.53	-0.84	6.61
7.7	-1.2	9.1	-1.8	10.9	-1.30	8.65	-1.6	9.8	-0.83	6.28	-1.17	7.29	-0.96	6.41
7.92	-1.4	8.8	-2.0	10.4	-1.47	8.34	-1.8	9.5	-0.96	6.08	-1.30	7.02	-1.09	6.18
8.14	-1.6	8.5	-2.2	10.0	-1.63	8.00	-1.9	9.1	-1.09	5.85	-1.43	6.72	-1.21	5.93
8.36	-1.8	8.1	-2.4	9.5	-1.80	7.63	-2.1	8.6	-1.23	5.60	-1.57	6.39	-1.33	5.65
8.58	-2.0	7.7	-2.6	8.9	-1.97	7.21	-2.3	8.1	-1.37	5.31	-1.70	6.03	-1.46	5.34
8.8	-2.2	7.2	-2.8	8.3	-2.15	6.76	-2.5	7.6	-1.51	4.99	-1.84	5.64	-1.59	5.01
9.02	-2.4	6.7	-3.0	7.7	-2.33	6.26	-2.7	7.0	-1.65	4.65	-1.98	5.22	-1.72	4.64
9.24	-2.6	6.2	-3.2	7.0	-2.51	5.73	-2.9	6.4	-1.80	4.27	-2.12	4.77	-1.86	4.25
9.46	-2.8	5.6	-3.4	6.3	-2.69	5.16	-3.1	5.8	-1.95	3.85	-2.26	4.28	-1.99	3.82
9.68	-3.0	4.9	-3.6	5.5	-2.87	4.55	-3.3	5.1	-2.10	3.41	-2.41	3.77	-2.13	3.37
9.9	-3.3	4.2	-3.8	4.7	-3.06	3.90	-3.5	4.4	-2.26	2.93	-2.56	3.22	-2.27	2.89
10.12	-3.5	3.5	-4.0	3.9	-3.25	3.20	-3.6	3.6	-2.42	2.42	-2.70	2.64	-2.41	2.37
10.34	-3.7	2.7	-4.2	3.0	-3.44	2.47	-3.9	2.7	-2.58	1.87	-2.85	2.03	-2.55	1.83
10.56	-3.9	1.8	-4.4	2.0	-3.64	1.69	-4.1	1.9	-2.74	1.28	-3.00	1.39	-2.70	1.25
10.78	-4.2	0.9	-4.6	1.0	-3.84	0.87	-4.3	1.0	-2.91	0.66	-3.16	0.71	-2.84	0.64
11	-4.4	0.0	-4.8	0.0	-4.04	0.00	-4.5	0.0	-3.08	0.00	-3.31	0.00	-2.99	0.00
	2.8	10.0	6.3	12.8	3.8	9.8	5.2	11.5	1.9	6.9	3.9	8.5	2.8	7.3
	-4.4	0.0	-4.8	0.0	-4.0	0.0	-4.5	0.0	-3.1	0.0	-3.3	0.0	-3.0	0.0

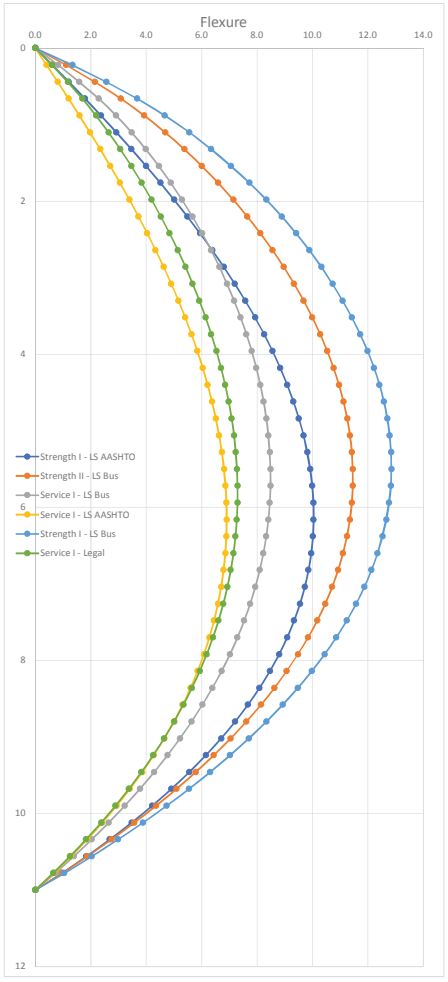
Loading Summary

	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal		Service I - Normal	
	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M
Pin Fix	5.36	10.36	6.02	13.04	4.96	10.11	5.54	11.70	3.73	7.14	4.10	8.67	3.67	7.49	2.98	5.59
Pin-Pin	4.42	10.04	6.32	12.85	4.04	9.85	5.25	11.45	3.08	6.91	3.89	8.48	2.99	7.29		
Max	**5.36**	**10.36**	**6.32**	**13.04**	**4.96**	**10.11**	**5.54**	**11.70**	**3.73**	**7.14**	**4.10**	**8.67**	**3.67**	**7.49**	**2.98**	**5.59**

	Str I			Str II	Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	**5.4**	**6.3**	**5.0**	**5.5**	**3.7**	**4.1**	**3.7**	**3.0**
Moment	**10.4**	**13.0**	**10.1**	**11.7**	**7.1**	**8.7**	**7.5**	**5.6**

Pin-Pin H = 11 ft





C/D Ratios

Shear and Moment

Capacities

Concrete Wall per ACI 318 Chapter 22

f'c_nom	2500	psi - Assumed nominal compressive strength
ϕcond	0.75	Condition Adjustment Factor
ϕshear	0.6	
ϕmoment	0.6	
f'c	1875	psi - Design compressive strength
d	18	in - Wall thickness at section under consideration
b	12	in - Unit width of wall
S	648	in3 - uncracked section modulus
Pwall	2153	lbs - axial load at mid height of wall
Pwalk	215	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	10.97	psi - axial stress at mid height of wall

Shear

Vn = 4/3*sqrt(f'c)*b*d

Vn	V
12.5	7.48

Flexure

Mn = 5*sqrt(f'c)*S (ACI 318 CH22)

fru = 5*sqrt(f'c) + Pu/A Add in compressive stress due to axial force

fru	Mn	phi*M
227.5	12.3	7.37

Brick Masonry Wall

f'm_nom	1000	psi - Assumed nominal compressive strength
fr_nom	30	psi - Assumed nominal modulus of rupture (tensile strength)
ϕcond	0.6	Condition Adjustment Factor
ϕshear	0.6	
ϕmoment	0.8	
f'm	600	psi - Design nominal compressive strength
fr	18	psi - Design nominal modulus of rupture (tensile strength)
d	24	in - Wall thickness
b	12	in - Wall width
An	288	in2
S	1152	in3 - uncracked section modulus
Pwall	2376	lbs - axial load at mid height of wall
Pwalk	215	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	9.00	psi - axial stress at mid height of wall

Shear

Vn = min	| 3.8*An*sqrt(f'm)	(1)	ACI 530
	| 300*An	(2)	
	| 90*An + 0.45*Nu	(3)	

Vn (1)	Vn (2)	Vn (3)	Vn	phi*V
26.8	86.4	25.92	25.92	15.55

Flexure

Mn = fru*S ACI 530

fru = fr + Pu/A

fru	Mn	phi*M
27.0	2.6	2.07

Stone Masonry Wall

ϕcond	0.6	
ϕshear	0.6	
ϕmoment	0.8	
f'm	600	psi - Design nominal compressive strength
fr	18	psi - Design nominal modulus of rupture (tensile strength)
d	24	in - Wall thickness
b	12	in - Wall width
An	288	in2
S	1152	in3 - uncracked section modulus
Scr	576	cracked section modulus
Pwall	3190	lbs - axial load at mid height of wall
Pwalk	239	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	11.91	psi - axial stress at mid height of wall

Shear

Vn = min	| 3.8*An*sqrt(f'm)	(1)	ACI 530
	| 300*An	(2)	
	| 90*An + 0.45*Nu	(3)	

Vn (1)	Vn (2)	Vn (3)	Vn	phi*V
26.8	86.4	25.92	25.92	15.55

Flexure

Mn = fru*S ACI 530

fru = fr + Pu/A

fru	Mn	phi*M
29.9	2.9	2.30

	phi*Vn	phi*Mn			
Concrete Wall	7.48	7.37	for d =	18	in
Brick Masonry	15.55	2.07	for d =	24	in
Stone Masonry	15.55	2.30	for d =	24	in

Factored Load Summary H = 11

	Str I			Str II		Ser I		
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	5.4	6.3	5.0	5.5	3.7	4.1	3.7	3.0
Moment	10.4	13.0	10.1	11.7	7.1	8.7	7.5	5.6

C/D Ratios - Brick Masonry

	Str I		Str II		Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	**2.90**	**2.46**	**3.14**	**2.81**	**4.17**	**3.79**	**4.24**	**5.22**
Moment	**0.20**	**0.16**	**0.21**	**0.18**	**0.29**	**0.24**	**0.28**	**0.37**
Bearing	0.54	0.45	0.55	0.49	0.72	0.62	0.69	0.85
Sliding	0.34	0.29	0.36	0.33	0.54	0.49	0.55	0.68

C/D Ratios - Stone Masonry

	Str I		Str II		Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	**2.90**	**2.46**	**3.14**	**2.81**	**4.17**	**3.79**	**4.24**	**5.22**
Moment	**0.22**	**0.18**	**0.23**	**0.20**	**0.32**	**0.26**	**0.31**	**0.41**
Bearing	0.53	0.44	0.54	0.48	0.69	0.60	0.67	0.82
Sliding	0.39	0.33	0.42	0.38	0.62	0.57	0.63	0.78

These values include condition and strength reduction factors. The values in the memo do not.

SINGLE-SPAN BEAM ANALYSIS

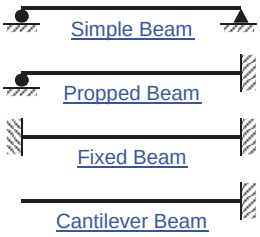
For Simple, Propped, Fixed, or Cantilever Beams

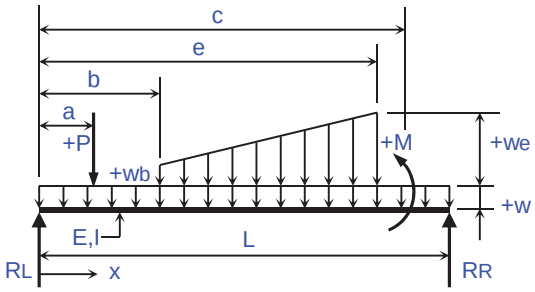
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - EH		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	11.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.0000	11.0000	0.6600
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	0.73 k	RR =	2.90 k
ML =	N.A.	MR =	-5.32 ft-k

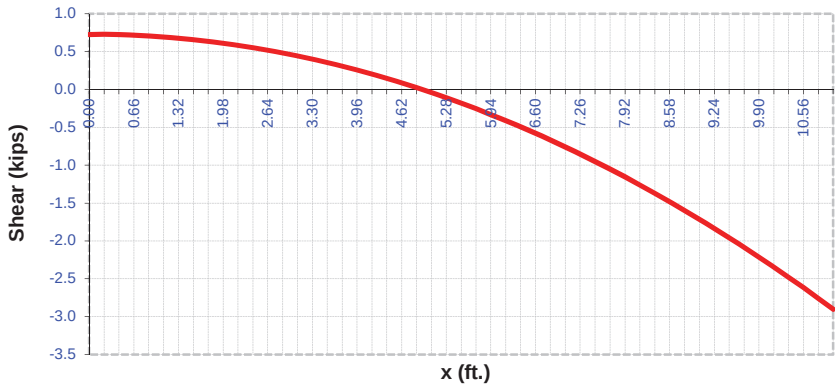
Maximum Moments:

+M(max) =	2.38 ft-k	@ x =	4.92 ft.
-M(max) =	-5.32 ft-k	@ x =	11.00 ft.

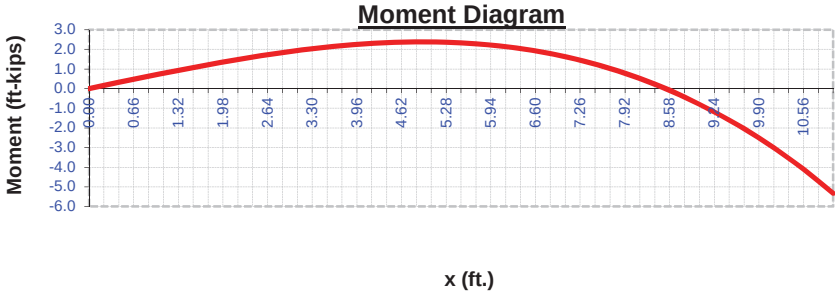
Maximum Deflections:

-Δ(max) =	-2.213 in.	@ x =	4.92 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/60		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	0.73	0.00	-3.3555	0.0000
2	0.2200	0.72	0.16	-3.3474	-0.1545
3	0.4400	0.72	0.32	-3.3233	-0.3082
4	0.6600	0.71	0.48	-3.2832	-0.4605
5	0.8800	0.70	0.63	-3.2273	-0.6105
6	1.1000	0.69	0.79	-3.1558	-0.7577
7	1.3200	0.67	0.94	-3.0690	-0.9011
8	1.5400	0.65	1.08	-2.9673	-1.0403
9	1.7600	0.63	1.22	-2.8511	-1.1744
10	1.9800	0.61	1.36	-2.7208	-1.3028
11	2.2000	0.58	1.49	-2.5770	-1.4249
12	2.4200	0.55	1.62	-2.4203	-1.5401
13	2.6400	0.52	1.73	-2.2515	-1.6477
14	2.8600	0.48	1.84	-2.0712	-1.7474
15	3.0800	0.44	1.94	-1.8802	-1.8384
16	3.3000	0.40	2.04	-1.6794	-1.9205
17	3.5200	0.35	2.12	-1.4698	-1.9931
18	3.7400	0.31	2.19	-1.2523	-2.0558
19	3.9600	0.26	2.25	-1.0281	-2.1084
20	4.1800	0.20	2.30	-0.7981	-2.1505
21	4.4000	0.15	2.34	-0.5637	-2.1818
22	4.6200	0.09	2.37	-0.3261	-2.2024
23	4.8400	0.02	2.38	-0.0866	-2.2119
24	5.0600	-0.04	2.38	0.1534	-2.2103
25	5.2800	-0.11	2.36	0.3925	-2.1977
26	5.5000	-0.18	2.33	0.6292	-2.1742
27	5.7200	-0.26	2.28	0.8617	-2.1398
28	5.9400	-0.33	2.22	1.0887	-2.0949
29	6.1600	-0.41	2.13	1.3082	-2.0396
30	6.3800	-0.50	2.03	1.5186	-1.9744
31	6.6000	-0.58	1.92	1.7180	-1.8998
32	6.8200	-0.67	1.78	1.9045	-1.8163
33	7.0400	-0.76	1.62	2.0762	-1.7246
34	7.2600	-0.86	1.44	2.2309	-1.6253
35	7.4800	-0.95	1.25	2.3667	-1.5193
36	7.7000	-1.05	1.02	2.4814	-1.4075
37	7.9200	-1.16	0.78	2.5727	-1.2910
38	8.1400	-1.26	0.52	2.6383	-1.1708
39	8.3600	-1.37	0.23	2.6760	-1.0483
40	8.5800	-1.48	-0.09	2.6832	-0.9247
41	8.8000	-1.60	-0.43	2.6575	-0.8015
42	9.0200	-1.71	-0.79	2.5964	-0.6803
43	9.2400	-1.84	-1.18	2.4973	-0.5628
44	9.4600	-1.96	-1.60	2.3574	-0.4508
45	9.6800	-2.09	-2.04	2.1741	-0.3462
46	9.9000	-2.21	-2.52	1.9445	-0.2512
47	10.1200	-2.35	-3.02	1.6658	-0.1678
48	10.3400	-2.48	-3.55	1.3350	-0.0985
49	10.5600	-2.62	-4.11	0.9492	-0.0456
50	10.7800	-2.76	-4.70	0.5052	-0.0119
51	11.0000	-2.90	-5.32	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

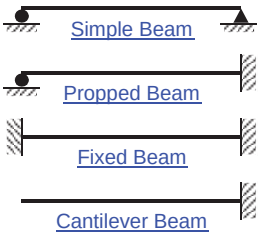
For Simple, Propped, Fixed, or Cantilever Beams

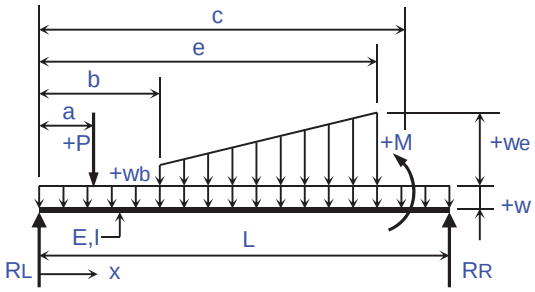
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS AASHTO		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	11.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = 0.1200 kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:				
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	0.50 k	RR =	0.83 k
ML =	N.A.	MR =	-1.82 ft-k

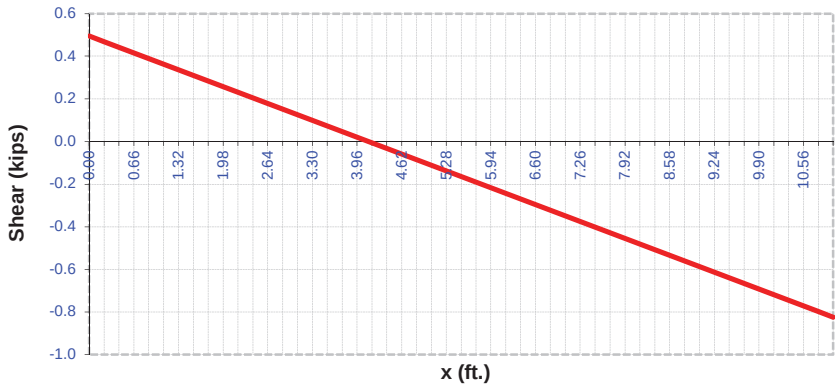
Maximum Moments:

+M(max) =	1.02 ft-k	@ x =	4.13 ft.
-M(max) =	-1.82 ft-k	@ x =	11.00 ft.

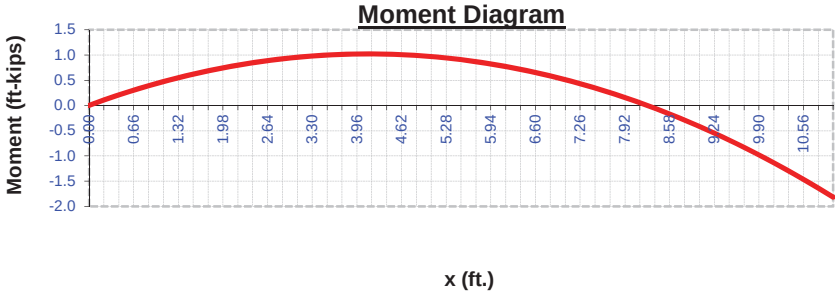
Maximum Deflections:

-Δ(max) =	-0.914 in.	@ x =	4.64 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/144		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	0.50	0.00	-1.5252	0.0000
2	0.2200	0.47	0.11	-1.5198	-0.0702
3	0.4400	0.44	0.21	-1.5040	-0.1399
4	0.6600	0.42	0.30	-1.4784	-0.2086
5	0.8800	0.39	0.39	-1.4436	-0.2760
6	1.1000	0.36	0.47	-1.4001	-0.3415
7	1.3200	0.34	0.55	-1.3486	-0.4049
8	1.5400	0.31	0.62	-1.2896	-0.4657
9	1.7600	0.28	0.69	-1.2238	-0.5236
10	1.9800	0.26	0.74	-1.1516	-0.5784
11	2.2000	0.23	0.80	-1.0738	-0.6297
12	2.4200	0.20	0.85	-0.9908	-0.6773
13	2.6400	0.18	0.89	-0.9032	-0.7209
14	2.8600	0.15	0.92	-0.8117	-0.7604
15	3.0800	0.13	0.96	-0.7169	-0.7957
16	3.3000	0.10	0.98	-0.6192	-0.8265
17	3.5200	0.07	1.00	-0.5194	-0.8527
18	3.7400	0.05	1.01	-0.4180	-0.8743
19	3.9600	0.02	1.02	-0.3155	-0.8912
20	4.1800	-0.01	1.02	-0.2126	-0.9034
21	4.4000	-0.03	1.02	-0.1098	-0.9108
22	4.6200	-0.06	1.01	-0.0078	-0.9135
23	4.8400	-0.09	0.99	0.0929	-0.9115
24	5.0600	-0.11	0.97	0.1917	-0.9050
25	5.2800	-0.14	0.94	0.2881	-0.8939
26	5.5000	-0.17	0.91	0.3813	-0.8785
27	5.7200	-0.19	0.87	0.4709	-0.8588
28	5.9400	-0.22	0.82	0.5562	-0.8351
29	6.1600	-0.24	0.77	0.6367	-0.8076
30	6.3800	-0.27	0.72	0.7118	-0.7765
31	6.6000	-0.30	0.65	0.7809	-0.7421
32	6.8200	-0.32	0.59	0.8434	-0.7047
33	7.0400	-0.35	0.51	0.8987	-0.6645
34	7.2600	-0.38	0.43	0.9463	-0.6220
35	7.4800	-0.40	0.35	0.9855	-0.5774
36	7.7000	-0.43	0.25	1.0158	-0.5313
37	7.9200	-0.46	0.16	1.0366	-0.4840
38	8.1400	-0.48	0.05	1.0472	-0.4359
39	8.3600	-0.51	-0.06	1.0472	-0.3876
40	8.5800	-0.53	-0.17	1.0359	-0.3396
41	8.8000	-0.56	-0.29	1.0127	-0.2924
42	9.0200	-0.59	-0.42	0.9771	-0.2465
43	9.2400	-0.61	-0.55	0.9285	-0.2025
44	9.4600	-0.64	-0.69	0.8662	-0.1611
45	9.6800	-0.67	-0.83	0.7898	-0.1229
46	9.9000	-0.69	-0.98	0.6985	-0.0885
47	10.1200	-0.72	-1.14	0.5919	-0.0588
48	10.3400	-0.75	-1.30	0.4694	-0.0342
49	10.5600	-0.77	-1.46	0.3302	-0.0158
50	10.7800	-0.80	-1.64	0.1740	-0.0041
51	11.0000	-0.83	-1.82	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

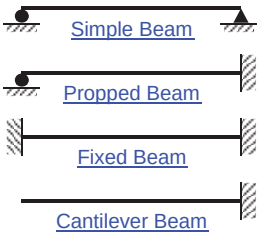
For Simple, Propped, Fixed, or Cantilever Beams

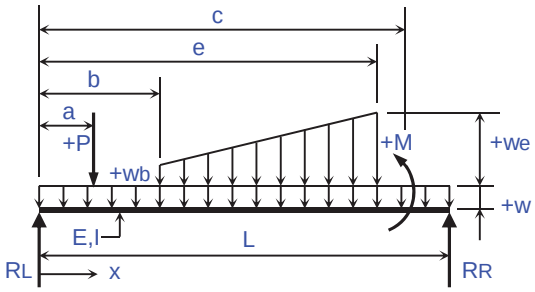
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Bus	
Job Number:		Originator:	SW	Checker:

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	11.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	1.4145	0.7500	1.4145
#2:	0.7500	1.4145	1.5000	0.5865
#3:	1.5000	0.5865	3.0000	0.2530
#4:	3.0000	0.2530	11.0000	0.0460
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	2.44 k	RR =	1.20 k
ML =	N.A.	MR =	-3.34 ft-k

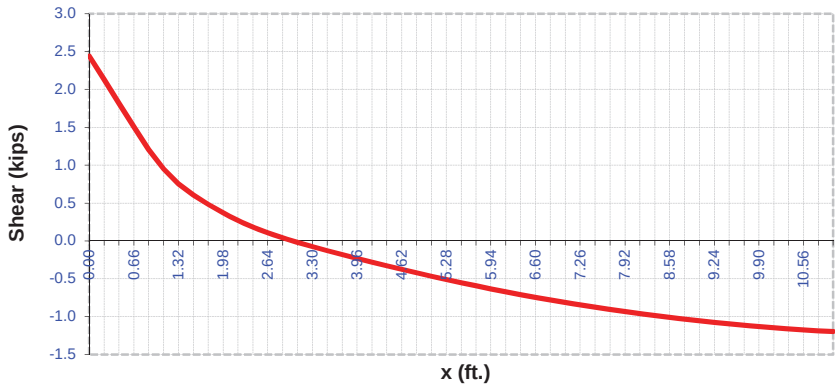
Maximum Moments:

+M(max) =	2.55 ft-k	@ x =	3.00 ft.
-M(max) =	-3.34 ft-k	@ x =	11.00 ft.

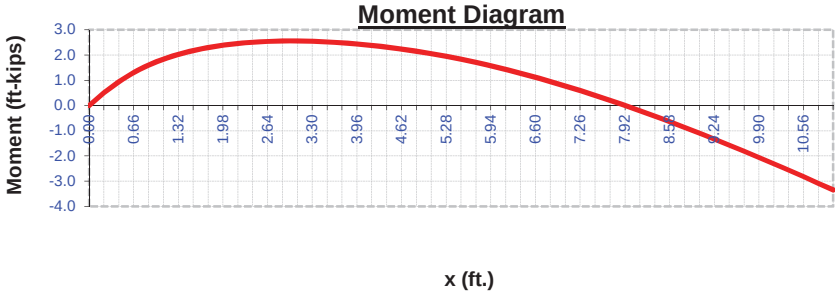
Maximum Deflections:

-Δ(max) =	-2.096 in.	@ x =	4.29 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/63		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	2.44	0.00	-4.0426	0.0000
2	0.2200	2.13	0.50	-4.0167	-0.1859
3	0.4400	1.82	0.94	-3.9436	-0.3694
4	0.6600	1.51	1.30	-3.8301	-0.5487
5	0.8800	1.20	1.60	-3.6833	-0.7219
6	1.1000	0.95	1.84	-3.5096	-0.8877
7	1.3200	0.75	2.02	-3.3147	-1.0450
8	1.5400	0.61	2.17	-3.1031	-1.1929
9	1.7600	0.48	2.29	-2.8780	-1.3307
10	1.9800	0.37	2.38	-2.6421	-1.4579
11	2.2000	0.27	2.45	-2.3980	-1.5741
12	2.4200	0.18	2.50	-2.1478	-1.6788
13	2.6400	0.10	2.54	-1.8935	-1.7719
14	2.8600	0.04	2.55	-1.6369	-1.8533
15	3.0800	-0.02	2.55	-1.3794	-1.9228
16	3.3000	-0.08	2.54	-1.1225	-1.9804
17	3.5200	-0.13	2.52	-0.8672	-2.0262
18	3.7400	-0.18	2.49	-0.6148	-2.0604
19	3.9600	-0.23	2.44	-0.3664	-2.0829
20	4.1800	-0.28	2.38	-0.1232	-2.0942
21	4.4000	-0.33	2.32	0.1138	-2.0944
22	4.6200	-0.38	2.24	0.3435	-2.0838
23	4.8400	-0.42	2.15	0.5648	-2.0629
24	5.0600	-0.47	2.05	0.7767	-2.0319
25	5.2800	-0.51	1.94	0.9783	-1.9914
26	5.5000	-0.55	1.83	1.1685	-1.9419
27	5.7200	-0.59	1.70	1.3465	-1.8840
28	5.9400	-0.63	1.57	1.5112	-1.8181
29	6.1600	-0.67	1.42	1.6620	-1.7449
30	6.3800	-0.71	1.27	1.7978	-1.6651
31	6.6000	-0.74	1.11	1.9180	-1.5795
32	6.8200	-0.78	0.94	2.0216	-1.4886
33	7.0400	-0.81	0.77	2.1079	-1.3934
34	7.2600	-0.84	0.59	2.1762	-1.2947
35	7.4800	-0.88	0.40	2.2258	-1.1932
36	7.7000	-0.90	0.20	2.2560	-1.0899
37	7.9200	-0.93	0.00	2.2661	-0.9856
38	8.1400	-0.96	-0.21	2.2555	-0.8813
39	8.3600	-0.99	-0.42	2.2236	-0.7781
40	8.5800	-1.01	-0.64	2.1699	-0.6768
41	8.8000	-1.03	-0.87	2.0938	-0.5784
42	9.0200	-1.06	-1.10	1.9947	-0.4842
43	9.2400	-1.08	-1.33	1.8722	-0.3950
44	9.4600	-1.10	-1.57	1.7258	-0.3120
45	9.6800	-1.11	-1.81	1.5552	-0.2363
46	9.9000	-1.13	-2.06	1.3598	-0.1691
47	10.1200	-1.15	-2.31	1.1393	-0.1114
48	10.3400	-1.16	-2.57	0.8934	-0.0645
49	10.5600	-1.17	-2.82	0.6218	-0.0295
50	10.7800	-1.19	-3.08	0.3240	-0.0076
51	11.0000	-1.20	-3.34	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

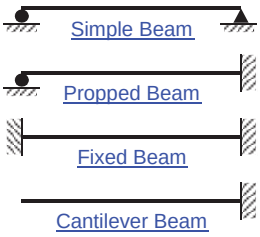
For Simple, Propped, Fixed, or Cantilever Beams

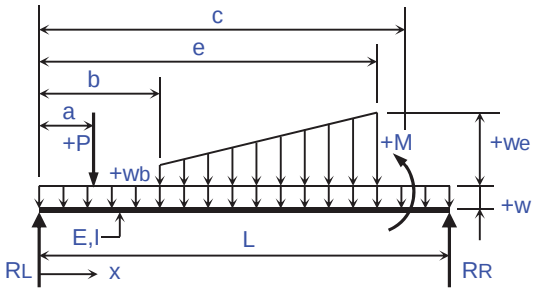
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Legal		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	11.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:

	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.7700	0.7500	0.7700
#2:	0.7500	0.7700	1.5000	0.3500
#3:	1.5000	0.3500	3.0000	0.1800
#4:	3.0000	0.1800	11.0000	0.0200
#5:				
#6:				
#7:				
#8:				

Point Loads:

	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:

	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	1.43 k	RR =	0.77 k
ML =	N.A.	MR =	-2.17 ft-k

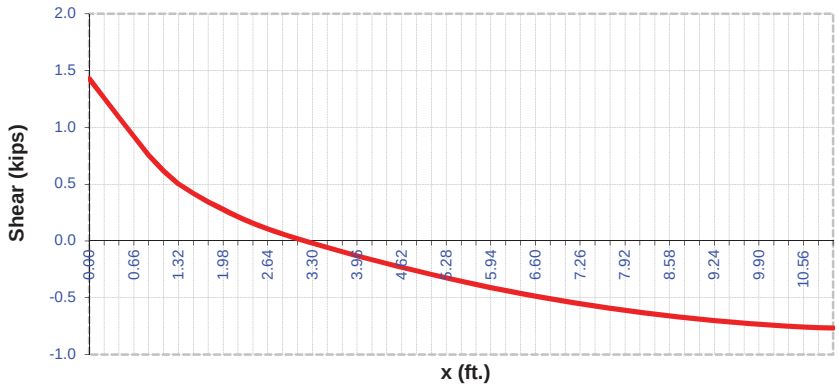
Maximum Moments:

+M(max) =	1.63 ft-k	@ x =	3.18 ft.
-M(max) =	-2.17 ft-k	@ x =	11.00 ft.

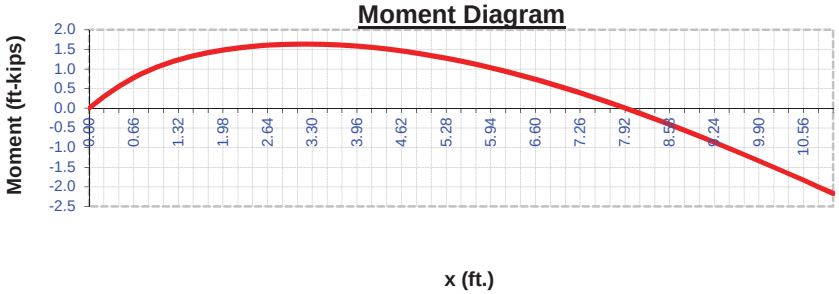
Maximum Deflections:

-Δ(max) =	-1.350 in.	@ x =	4.33 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/98		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	1.43	0.00	-2.5577	0.0000
2	0.2200	1.26	0.30	-2.5425	-0.1176
3	0.4400	1.09	0.55	-2.4994	-0.2339
4	0.6600	0.92	0.77	-2.4322	-0.3476
5	0.8800	0.75	0.96	-2.3445	-0.4577
6	1.1000	0.61	1.11	-2.2401	-0.5634
7	1.3200	0.50	1.23	-2.1219	-0.6639
8	1.5400	0.42	1.33	-1.9926	-0.7587
9	1.7600	0.34	1.41	-1.8541	-0.8474
10	1.9800	0.27	1.48	-1.7079	-0.9295
11	2.2000	0.21	1.54	-1.5556	-1.0047
12	2.4200	0.16	1.58	-1.3986	-1.0728
13	2.6400	0.10	1.60	-1.2381	-1.1335
14	2.8600	0.06	1.62	-1.0753	-1.1868
15	3.0800	0.02	1.63	-0.9112	-1.2326
16	3.3000	-0.02	1.63	-0.7467	-1.2708
17	3.5200	-0.06	1.62	-0.5827	-1.3014
18	3.7400	-0.10	1.60	-0.4199	-1.3245
19	3.9600	-0.13	1.58	-0.2593	-1.3402
20	4.1800	-0.17	1.55	-0.1015	-1.3485
21	4.4000	-0.20	1.51	0.0525	-1.3496
22	4.6200	-0.23	1.46	0.2021	-1.3437
23	4.8400	-0.27	1.40	0.3466	-1.3310
24	5.0600	-0.30	1.34	0.4851	-1.3118
25	5.2800	-0.33	1.27	0.6171	-1.2864
26	5.5000	-0.36	1.20	0.7419	-1.2551
27	5.7200	-0.38	1.12	0.8588	-1.2182
28	5.9400	-0.41	1.03	0.9671	-1.1761
29	6.1600	-0.44	0.94	1.0664	-1.1292
30	6.3800	-0.46	0.84	1.1560	-1.0779
31	6.6000	-0.49	0.73	1.2354	-1.0228
32	6.8200	-0.51	0.62	1.3040	-0.9643
33	7.0400	-0.53	0.51	1.3612	-0.9028
34	7.2600	-0.55	0.39	1.4067	-0.8390
35	7.4800	-0.57	0.27	1.4399	-0.7734
36	7.7000	-0.59	0.14	1.4604	-0.7065
37	7.9200	-0.61	0.01	1.4678	-0.6390
38	8.1400	-0.63	-0.13	1.4615	-0.5715
39	8.3600	-0.65	-0.27	1.4414	-0.5045
40	8.5800	-0.66	-0.41	1.4069	-0.4388
41	8.8000	-0.68	-0.56	1.3578	-0.3751
42	9.0200	-0.69	-0.71	1.2937	-0.3140
43	9.2400	-0.70	-0.86	1.2143	-0.2561
44	9.4600	-0.71	-1.02	1.1194	-0.2023
45	9.6800	-0.72	-1.18	1.0086	-0.1532
46	9.9000	-0.73	-1.34	0.8818	-0.1096
47	10.1200	-0.74	-1.50	0.7387	-0.0722
48	10.3400	-0.75	-1.66	0.5791	-0.0418
49	10.5600	-0.76	-1.83	0.4029	-0.0191
50	10.7800	-0.76	-2.00	0.2099	-0.0049
51	11.0000	-0.77	-2.17	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

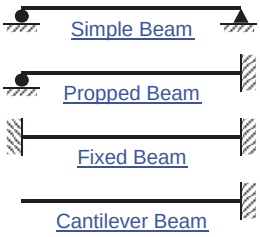
For Simple, Propped, Fixed, or Cantilever Beams

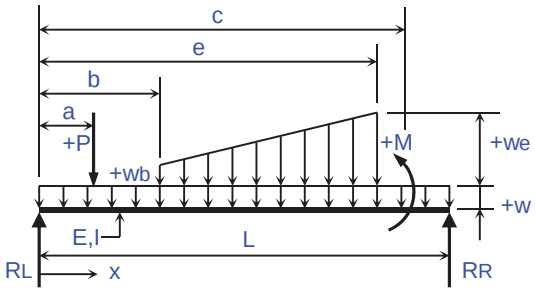
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Normal Traffic	
Job Number:		Originator:	SW	Checker:

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	11.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.3400	3.1000	0.0000
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	0.45 k	RR =	0.07 k
ML =	N.A.	MR =	-0.27 ft-k

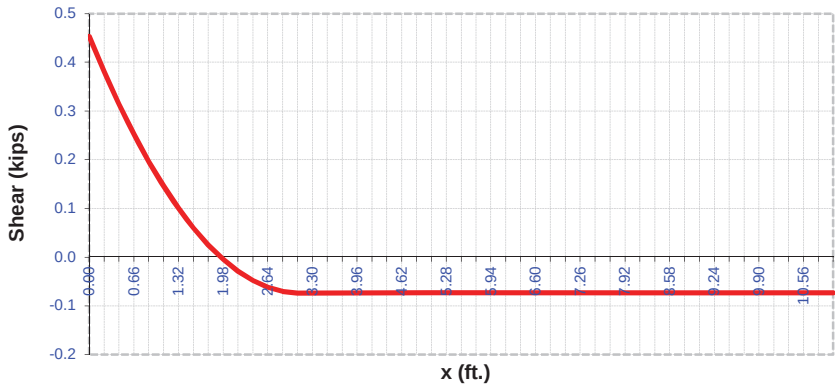
Maximum Moments:

+M(max) =	0.37 ft-k	@ x =	1.94 ft.
-M(max) =	-0.27 ft-k	@ x =	11.00 ft.

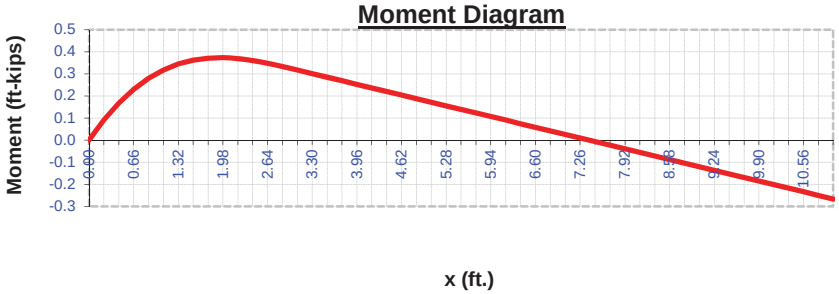
Maximum Deflections:

-Δ(max) =	-0.221 in.	@ x =	3.79 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/596		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	0.45	0.00	-0.5093	0.0000
2	0.2200	0.38	0.09	-0.5046	-0.0234
3	0.4400	0.31	0.17	-0.4914	-0.0464
4	0.6600	0.25	0.23	-0.4711	-0.0686
5	0.8800	0.20	0.28	-0.4453	-0.0897
6	1.1000	0.15	0.32	-0.4151	-0.1095
7	1.3200	0.10	0.34	-0.3817	-0.1279
8	1.5400	0.06	0.36	-0.3460	-0.1447
9	1.7600	0.02	0.37	-0.3090	-0.1598
10	1.9800	0.00	0.37	-0.2715	-0.1731
11	2.2000	-0.03	0.37	-0.2340	-0.1848
12	2.4200	-0.05	0.36	-0.1972	-0.1947
13	2.6400	-0.06	0.35	-0.1614	-0.2030
14	2.8600	-0.07	0.33	-0.1270	-0.2096
15	3.0800	-0.07	0.32	-0.0941	-0.2147
16	3.3000	-0.07	0.30	-0.0629	-0.2183
17	3.5200	-0.07	0.29	-0.0334	-0.2205
18	3.7400	-0.07	0.27	-0.0054	-0.2214
19	3.9600	-0.07	0.25	0.0209	-0.2210
20	4.1800	-0.07	0.24	0.0456	-0.2195
21	4.4000	-0.07	0.22	0.0686	-0.2169
22	4.6200	-0.07	0.20	0.0900	-0.2132
23	4.8400	-0.07	0.19	0.1098	-0.2086
24	5.0600	-0.07	0.17	0.1280	-0.2031
25	5.2800	-0.07	0.16	0.1445	-0.1968
26	5.5000	-0.07	0.14	0.1593	-0.1898
27	5.7200	-0.07	0.12	0.1726	-0.1822
28	5.9400	-0.07	0.11	0.1842	-0.1739
29	6.1600	-0.07	0.09	0.1942	-0.1652
30	6.3800	-0.07	0.07	0.2025	-0.1561
31	6.6000	-0.07	0.06	0.2092	-0.1466
32	6.8200	-0.07	0.04	0.2143	-0.1368
33	7.0400	-0.07	0.03	0.2177	-0.1269
34	7.2600	-0.07	0.01	0.2195	-0.1168
35	7.4800	-0.07	-0.01	0.2197	-0.1067
36	7.7000	-0.07	-0.02	0.2182	-0.0966
37	7.9200	-0.07	-0.04	0.2151	-0.0866
38	8.1400	-0.07	-0.06	0.2103	-0.0768
39	8.3600	-0.07	-0.07	0.2040	-0.0672
40	8.5800	-0.07	-0.09	0.1960	-0.0580
41	8.8000	-0.07	-0.10	0.1863	-0.0492
42	9.0200	-0.07	-0.12	0.1750	-0.0409
43	9.2400	-0.07	-0.14	0.1621	-0.0331
44	9.4600	-0.07	-0.15	0.1476	-0.0260
45	9.6800	-0.07	-0.17	0.1314	-0.0195
46	9.9000	-0.07	-0.18	0.1136	-0.0139
47	10.1200	-0.07	-0.20	0.0941	-0.0091
48	10.3400	-0.07	-0.22	0.0731	-0.0052
49	10.5600	-0.07	-0.23	0.0503	-0.0024
50	10.7800	-0.07	-0.25	0.0260	-0.0006
51	11.0000	-0.07	-0.27	0.0000	0.0000

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Brick Wall (Sliding and Bearing)
Date: 10/31/2018
By: RL with SJW edits

Wall Properties

Wall Height, H	=	11	ft	
Stem/Footing Unit Weight		120	pcf	Use 120 pcf for brick, 150 pcf for masonry rubble
Stem Thickness	=	2	ft	Chudgar use 1.00 ft
Footing Thickness	=	1.5	ft	Chudgar use 1.25 ft
Footing Width	=	3.34	ft	
Area of Footing (A)	=	5.01	ft^2/ft	
Sidewalk Width	=	16	ft	
Sidewalk Thickness	=	0.33	ft	
Footing Heel Width	=	0.67	ft	
Soil Unit Weight	=	120	pcf	

Active Pressure

Laterial Earth Pressure (EH)	=	60	pcf	At-Rest

Passive Pressure

Soil in Front of Footing	=	0	pcf	Neglect

Other Loading

Sidewalk Dead Load (DW)	=	50	psf	Assume 4" sidewalk, Chudgar use 75 psf
Pedestrian Live Load (PL)	=	75	psf	Chudgar use 250 psf

CHECK SLIDING

Resisting Force ↓

Weight of Stem (DC)	=	2280.00	lb/ft
Weight of Footing (DC)	=	601.20	lb/ft
Soil Weight Behind Wall (EV)	=	763.80	lb/ft
Sidewalk Dead Load (DW)	=	400	lb/ft
Pedestrian Live Load (PL)	=	600	lb/ft

Neglect PL when check sliding

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)			Load Combination 4 (Active + Truck Type 3)		
Sliding				Sliding			Sliding		
Factored Driving Force ←	=	5364 lb/ft	From "Wall Analysis"	Factored Driving Force ←	6317 lb/ft	From "Wall Analysis"	Factored Driving Force ←	4957 lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	3617 lb/ft		Factored Vertical Force ↓	3617 lb/ft		Factored Vertical Force ↓	3617 lb/ft	
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58
Capacity/Demand Ratio	=	0.34		Capacity/Demand Ratio	0.29		Capacity/Demand Ratio	0.36	

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)			Load Combination 4 (Active + Truck Type 3)		
Sliding				Sliding			Sliding		
Factored Driving Force ←	=	5745 lb/ft	From RISA	Factored Driving Force ←	5537 lb/ft	From "Wall Analysis"	Factored Driving Force ←	4957 lb/ft	From RISA
Factored Vertical Force ↓	=	3617 lb/ft		Factored Vertical Force ↓	3617 lb/ft		Factored Vertical Force ↓	3617 lb/ft	
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58
Capacity/Demand Ratio	=	0.31		Capacity/Demand Ratio	0.33		Capacity/Demand Ratio	0.36	

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)			Load Combination 4 (Active + Truck Type 3)			Load Combination 4 (Normal Traffic)		
Sliding				Sliding			Sliding			Sliding		
Factored Driving Force ←	=	3729 lb/ft	From "Wall Analysis"	Factored Driving Force ←	4101 lb/ft	From "Wall Analysis"	Factored Driving Force ←	3672 lb/ft	From "Wall Analysis"	Factored Driving Force ←	2977.669 lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	4045 lb/ft		Factored Vertical Force ↓	4045 lb/ft		Factored Vertical Force ↓	4045 lb/ft		Factored Vertical Force ↓	4045 lb/ft	
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58
Capacity/Demand Ratio	=	0.54		Capacity/Demand Ratio	0.49		Capacity/Demand Ratio	0.55		Capacity/Demand Ratio	0.68	

SDOT
Seattle Department of Transportation

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Brick Wall (Sliding and Bearing)
Date: 10/31/2018
By: RL with SJW edits

CHECK BEARING PRESSURE

Allowable Bearing Pressure	=	2500	psf	AASHTO LRFD C10.6.2.6.1-1
Ultimate Bearing Pressure Factor	=	3		AASHTO LRFD C10.5.5.2.2
Ultimate Bearing Pressue	=	7500	psf	
Weight of Stem (DC)	=	2280.00	lb/ft	
Weight of Footing (DC)	=	601.20	lb/ft	
Sidewalk Dead Load (DW))	=	400	lb/ft	
Soil Weight Behind Wall (EV)	=	763.80	lb/ft	
Sidewalk Live Load (PL)	=	600	lb/ft	
Footing Thickness	=	1.5	ft	
Footing Width, L	=	3.34	ft	
Moment of Intertia (I)	=	3.105	ft^4/ft	3.76
Perdendicular Dist to Neut Axis (c)	=	1.67	ft	
Area of Footing (A)	=	3.34	ft^2/ft	

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS + 1.75PL

Load Combination 1 (Active + AASHTO Traffic)					Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Bearing					Bearing				Bearing			
Overturning Moment	=	10364	lb-ft/ft	From "Wall Analysis"	Overturning Moment	13041	lb-ft/ft	From "Wall Analysis"	Overturning Moment	10111	lb-ft/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	4667	lb/ft		Factored Vertical Force ↓	4667	lb/ft		Factored Vertical Force ↓	4667	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		6971	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	8411	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6836	psf/ft	
Ultimate Bearing Pressure	=	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55
Capacity/Demand Ratio	=	0.54		Chudgar has 0.07	Capacity/Demand Ratio	0.45			Capacity/Demand Ratio	0.55		

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS + 1.35PL

Load Combination 1 (Active + AASHTO Traffic)					Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Bearing					Bearing				Bearing			
Overturning Moment	=	10927	lb-ft/ft	From RISA	Overturning Moment	11703	lb-ft/ft	From "Wall Analysis"	Overturning Moment	10111	lb-ft/ft	From RISA
Factored Vertical Force ↓	=	4427	lb/ft		Factored Vertical Force ↓	4427	lb/ft		Factored Vertical Force ↓	4427	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		7202	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	7620	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6764	psf/ft	
Ultimate Bearing Pressure	=	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55
Capacity/Demand Ratio	=	0.52		Chudgar has 0.07	Capacity/Demand Ratio	0.49			Capacity/Demand Ratio	0.55		

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS + 1.0PL

Load Combination 1 (Active + AASHTO Traffic)					Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)				Load Combination 4 (Active + Normal Traffic)		
Bearing					Bearing				Bearing				Bearing		
Overturning Moment	=	7139	lb-ft/ft	From "Wall Analysis"	Overturning Moment	8669	lb-ft/ft	From "Wall Analysis"	Overturning Moment	7490	lb-ft/ft	From "Wall Analysis"	Overturning Moment	5590	lb-ft/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	4645	lb/ft		Factored Vertical Force ↓	4645	lb/ft		Factored Vertical Force ↓	4645	lb/ft		Factored Vertical Force ↓	4645	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		5230	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6053	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	5419	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	4397	psf/ft	
Allowable Bearing Pressure	=	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate
Capacity/Demand Ratio	=	0.72		Chudgar has 0.20	Capacity/Demand Ratio	0.62			Capacity/Demand Ratio	0.69			Capacity/Demand Ratio	0.85		

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Brick Wall (Sliding and Bearing)
Date: 10/31/2018
By: RL w/ SJW edits

Wall Properties

Wall Height, H	=	11	ft	
Stem/Footing Unit Weight		145	pcf	Use 120 pcf for brick, 150 pcf for masonry rubble
Stem Thickness	=	2	ft	Chudgar use 1.00 ft
Footing Thickness	=	1.5	ft	Chudgar use 1.25 ft
Footing Width	=	3.34	ft	
Area of Footing (A)	=	5.01	ft^2/ft	
Sidewalk Width	=	16	ft	
Sidewalk Thickness	=	0.33	ft	
Footing Heel Width	=	0.67	ft	
Soil Unit Weight	=	120	pcf	

Active Pressure

Laterial Earth Pressure (EH)	=	60	pcf	At-Rest

Passive Pressure

Soil in Front of Footing	=	0	pcf	Neglect

Other Loading

Sidewalk Dead Load (DW)	=	50	psf	Assume 4" sidewalk, Chudgar use 75 psf
Pedestrian Live Load (PL)	=	75	psf	Chudgar use 250 psf

CHECK SLIDING

Resisting Force ↓

Weight of Stem (DC)	=	2755.00	lb/ft	
Weight of Footing (DC)	=	726.45	lb/ft	
Soil Weight Behind Wall (EV)	=	763.80	lb/ft	
Sidewalk Dead Load (DW)	=	400	lb/ft	
Pedestrian Live Load (PL)	=	600	lb/ft	Neglect PL when check sliding

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS

Load Combination 1 (Active + AASHTO Traffic)

Sliding

Factored Driving Force ←	=	5364	lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	4157	lb/ft	
Coefficient of Friction	=	0.50		Chudgar use 0.58
Capacity/Demand Ratio	=	0.39		

Load Combination 3 (Active + Bus)

Sliding

Factored Driving Force ←	6317	lb/ft	From "Wall Analysis"	
Factored Vertical Force ↓	4157	lb/ft		
Coefficient of Friction	0.50		Chudgar use 0.58	
Capacity/Demand Ratio	0.33			

Load Combination 4 (Active + Truck Type 3)

Sliding

Factored Driving Force ←	4957	lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	4157	lb/ft	
Coefficient of Friction	0.50		Chudgar use 0.58
Capacity/Demand Ratio	0.42		

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS

Load Combination 1 (Active + AASHTO Traffic)

Sliding

Factored Driving Force ←	=	5745	lb/ft	From RISA
Factored Vertical Force ↓	=	4157	lb/ft	
Coefficient of Friction	=	0.50		Chudgar use 0.58
Capacity/Demand Ratio	=	0.36		

Load Combination 3 (Active + Bus)

Sliding

Factored Driving Force ←	5537	lb/ft	From "Wall Analysis"	
Factored Vertical Force ↓	4157	lb/ft		
Coefficient of Friction	0.50		Chudgar use 0.58	
Capacity/Demand Ratio	0.38			

Load Combination 4 (Active + Truck Type 3)

Sliding

Factored Driving Force ←	4957	lb/ft	From RISA
Factored Vertical Force ↓	4157	lb/ft	
Coefficient of Friction	0.50		Chudgar use 0.58
Capacity/Demand Ratio	0.42		

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS

Load Combination 1 (Active + AASHTO Traffic)

Sliding

Factored Driving Force ←	=	3729	lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	4645	lb/ft	
Coefficient of Friction	=	0.50		Chudgar use 0.58
Capacity/Demand Ratio	=	0.62		

Load Combination 3 (Active + Bus)

Sliding

Factored Driving Force ←	4101	lb/ft	From "Wall Analysis"	
Factored Vertical Force ↓	4645	lb/ft		
Coefficient of Friction	0.50		Chudgar use 0.58	
Capacity/Demand Ratio	0.57			

Load Combination 4 (Active + Truck Type 3)

Sliding

Factored Driving Force ←	3672	lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	4645	lb/ft	
Coefficient of Friction	0.50		Chudgar use 0.58
Capacity/Demand Ratio	0.63		

Load Combination 4 (Active + Normal Traffic)

Sliding

Factored Driving Force ←	2978	lb/ft	From "Wall Analysis"
Factored Vertical Force ↓	4645	lb/ft	
Coefficient of Friction	0.50		Chudgar use 0.58
Capacity/Demand Ratio	0.78		

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Brick Wall (Sliding and Bearing)
Date: 10/31/2018
By: RL w/ SJW edits

CHECK BEARING PRESSURE

Allowable Bearing Pressure	=	2500	psf	AASHTO LRFD C10.6.2.6.1-1
Ultimate Bearing Pressure Factor	=	3		AASHTO LRFD C10.5.5.2.2
Ultimate Bearing Pressue	=	7500	psf	
Weight of Stem (DC)	=	2755.00	lb/ft	
Weight of Footing (DC)	=	726.45	lb/ft	
Sidewalk Dead Load (DW))	=	400	lb/ft	
Soil Weight Behind Wall (EV)	=	763.80	lb/ft	
Sidewalk Live Load (PL)	=	600	lb/ft	
Footing Thickness	=	1.5	ft	
Footing Width, L	=	3.34	ft	
Moment of Intertia (I)	=	3.105	ft^4/ft	3.76
Perdendicular Dist to Neut Axis (c)	=	1.67	ft	
Area of Footing (A)	=	3.34	ft^2/ft	

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS + 1.75PL

Load Combination 1 (Active + AASHTO Traffic)				**Load Combination 3 (Active + Bus)**				**Load Combination 4 (Active + Truck Type 3)**			
Bearing				Bearing				Bearing			
Overturning Moment	=	10364	lb-ft/ft	Overturning Moment	13041	lb-ft/ft	From "Wall Analysis"	Overturning Moment	10111	lb-ft/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	5207	lb/ft	Factored Vertical Force ↓	5207	lb/ft		Factored Vertical Force ↓	5207	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		7133	psf/ft	Factored Bearing Pressure (P/A + M*c/I)	8573	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6997	psf/ft	
Ultimate Bearing Pressure	=	3750	psf	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55
Capacity/Demand Ratio	=	0.53	Chudgar has 0.07	Capacity/Demand Ratio	0.44			Capacity/Demand Ratio	0.54		

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS + 1.35PL

Load Combination 1 (Active + AASHTO Traffic)				**Load Combination 3 (Active + Bus)**				**Load Combination 4 (Active + Truck Type 3)**			
Bearing				Bearing				Bearing			
Overturning Moment	=	10927	lb-ft/ft	From RISA	Overturning Moment	11703	lb-ft/ft	From "Wall Analysis"	Overturning Moment	10111	lb-ft/ft	From RISA
Factored Vertical Force ↓	=	4967	lb/ft		Factored Vertical Force ↓	4967	lb/ft		Factored Vertical Force ↓	4967	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		7364	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	7781	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6926	psf/ft	
Ultimate Bearing Pressure	=	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750	psf	Chudgar factored in 0.55
Capacity/Demand Ratio	=	0.51	Chudgar has 0.07		Capacity/Demand Ratio	0.48			Capacity/Demand Ratio	0.54		

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS + 1.0PL

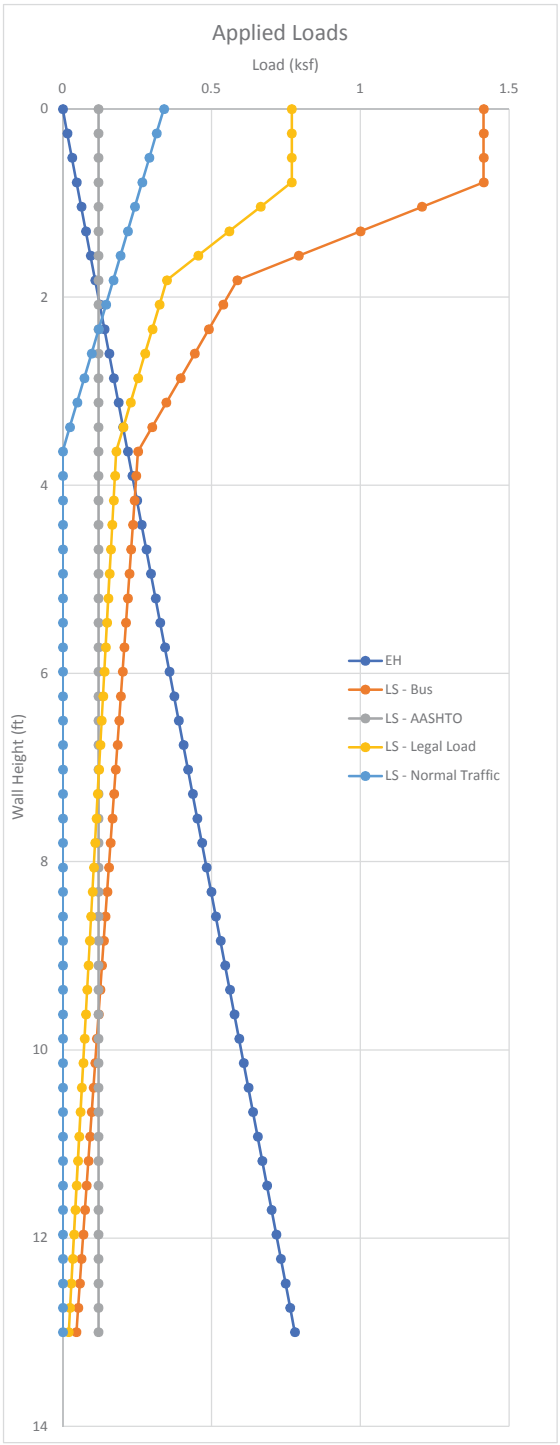
Load Combination 1 (Active + AASHTO Traffic)				**Load Combination 3 (Active + Bus)**				**Load Combination 4 (Active + Truck Type 3)**				**Load Combination 4 (Active + Normal Traffic)**			
Bearing				Bearing				Bearing				Bearing			
Overturning Moment	=	7139	lb-ft/ft	From "Wall Analysis"	Overturning Moment	8669	lb-ft/ft	From "Wall Analysis"	Overturning Moment	7490	lb-ft/ft	From "Wall Analysis"	Overturning Moment	5590	lb-ft/ft	From "Wall Analysis"
Factored Vertical Force ↓	=	5245	lb/ft		Factored Vertical Force ↓	5245	lb/ft		Factored Vertical Force ↓	5245	lb/ft		Factored Vertical Force ↓	5245	lb/ft	
Factored Bearing Pressure (P/A + M*c/I)		5410	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	6233	psf/ft		Factored Bearing Pressure (P/A + M*c/I)	5599	psf/ft		Factored Bearing Pressure (P/A + M* c/I)	4577	psf/ft	
Allowable Bearing Pressure	=	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750	psf	Chudgar use Ultimate
Capacity/Demand Ratio	=	0.69	Chudgar has 0.20		Capacity/Demand Ratio	0.60			Capacity/Demand Ratio	0.67			Capacity/Demand Ratio	0.82		

Loading Analysis

Compare Cantilever Loading vs. Simply Supported and Fix-Pin Supported

Loading			
Soil	gamma	120	
	phi	32	
EH	ko	0.5	
LS - AASHTO		120	PSF
H		13	feet

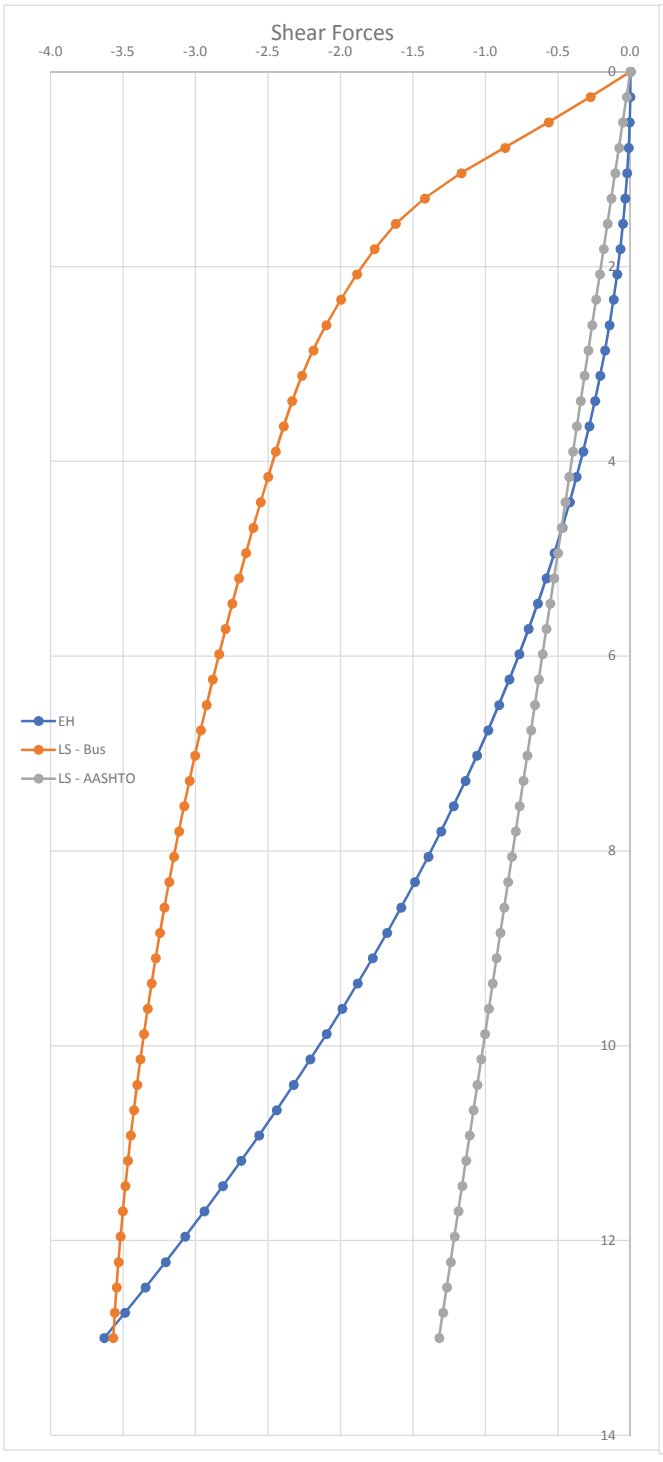
H	EH - Tri	LS - AASHTO	LS - Bus	LS - Legal Load	LS - Normal Traffic
0	0	0.12	1.41	0.77	0.34
0.26	0.0156	0.12	1.41	0.77	0.32
0.52	0.0312	0.12	1.41	0.77	0.29
0.78	0.0468	0.12	1.41	0.77	0.27
1.04	0.0624	0.12	1.21	0.67	0.24
1.3	0.078	0.12	1.00	0.56	0.22
1.56	0.0936	0.12	0.79	0.46	0.19
1.82	0.1092	0.12	0.59	0.35	0.17
2.08	0.1248	0.12	0.54	0.33	0.15
2.34	0.1404	0.12	0.49	0.30	0.12
2.6	0.156	0.12	0.44	0.28	0.10
2.86	0.1716	0.12	0.40	0.25	0.07
3.12	0.1872	0.12	0.35	0.23	0.05
3.38	0.2028	0.12	0.30	0.20	0.02
3.64	0.2184	0.12	0.25	0.18	0.00
3.9	0.234	0.12	0.25	0.18	0.00
4.16	0.2496	0.12	0.24	0.17	0.00
4.42	0.2652	0.12	0.24	0.17	0.00
4.68	0.2808	0.12	0.23	0.16	0.00
4.94	0.2964	0.12	0.22	0.16	0.00
5.2	0.312	0.12	0.22	0.15	0.00
5.46	0.3276	0.12	0.21	0.15	0.00
5.72	0.3432	0.12	0.21	0.14	0.00
5.98	0.3588	0.12	0.20	0.14	0.00
6.24	0.3744	0.12	0.20	0.14	0.00
6.5	0.39	0.12	0.19	0.13	0.00
6.76	0.4056	0.12	0.18	0.13	0.00
7.02	0.4212	0.12	0.18	0.12	0.00
7.28	0.4368	0.12	0.17	0.12	0.00
7.54	0.4524	0.12	0.17	0.11	0.00
7.8	0.468	0.12	0.16	0.11	0.00
8.06	0.4836	0.12	0.16	0.10	0.00
8.32	0.4992	0.12	0.15	0.10	0.00
8.58	0.5148	0.12	0.14	0.10	0.00
8.84	0.5304	0.12	0.14	0.09	0.00
9.1	0.546	0.12	0.13	0.09	0.00
9.36	0.5616	0.12	0.13	0.08	0.00
9.62	0.5772	0.12	0.12	0.08	0.00
9.88	0.5928	0.12	0.12	0.07	0.00
10.14	0.6084	0.12	0.11	0.07	0.00
10.4	0.624	0.12	0.10	0.06	0.00
10.66	0.6396	0.12	0.10	0.06	0.00
10.92	0.6552	0.12	0.09	0.06	0.00
11.18	0.6708	0.12	0.09	0.05	0.00
11.44	0.6864	0.12	0.08	0.05	0.00
11.7	0.702	0.12	0.07	0.04	0.00
11.96	0.7176	0.12	0.07	0.04	0.00
12.22	0.7332	0.12	0.06	0.03	0.00
12.48	0.7488	0.12	0.06	0.03	0.00
12.74	0.7644	0.12	0.05	0.02	0.00
13	0.78	0.12	0.05	0.02	0.00

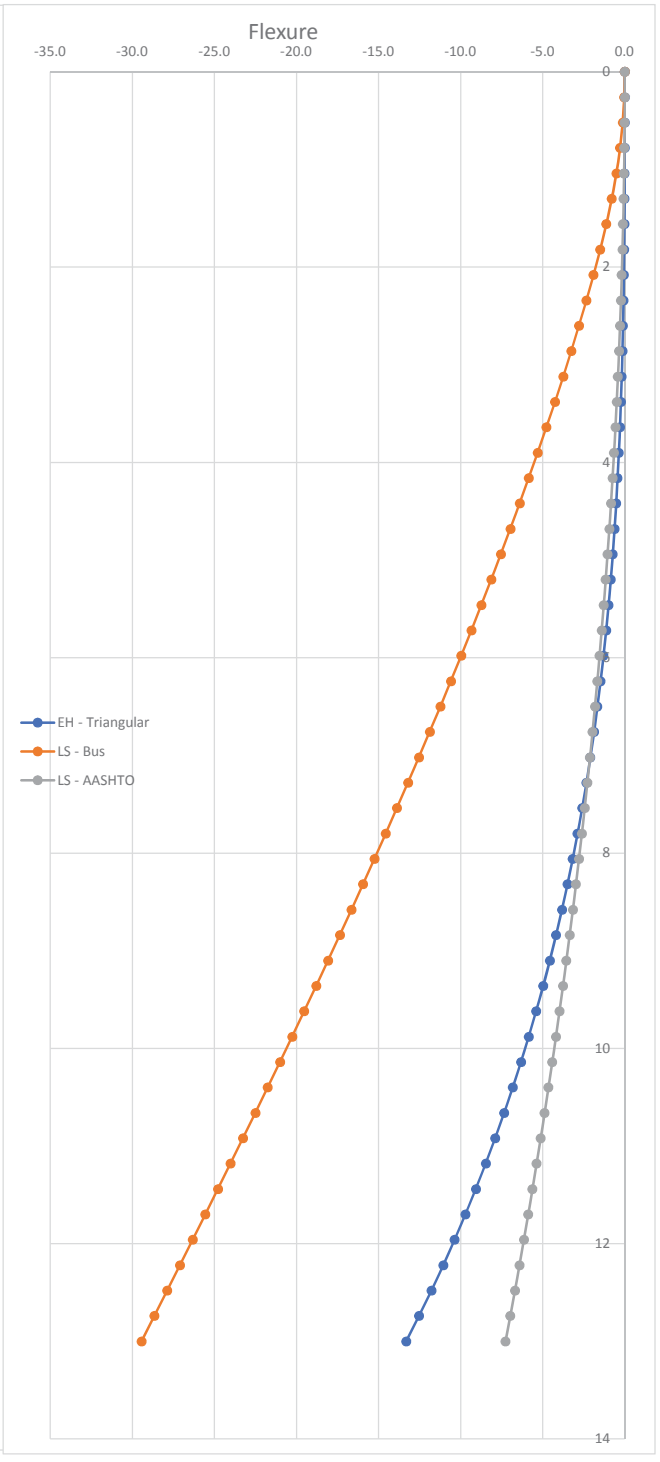


Cantilever H = 13 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0	0.0	-0.03	0.00	-0.28	-0.03	-0.17	-0.02	-0.07	-0.01
0.0	0.0	-0.05	-0.01	-0.57	-0.12	-0.34	-0.07	-0.14	-0.03
0.0	0.0	-0.08	-0.03	-0.87	-0.28	-0.51	-0.17	-0.20	-0.07
0.0	0.0	-0.11	-0.05	-1.17	-0.50	-0.67	-0.30	-0.26	-0.12
0.0	0.0	-0.13	-0.07	-1.42	-0.79	-0.81	-0.46	-0.31	-0.18
-0.1	0.0	-0.16	-0.10	-1.62	-1.12	-0.93	-0.65	-0.35	-0.25
-0.1	0.0	-0.18	-0.14	-1.77	-1.50	-1.01	-0.87	-0.39	-0.34
-0.1	-0.1	-0.21	-0.19	-1.89	-1.90	-1.08	-1.10	-0.43	-0.43
-0.1	-0.1	-0.24	-0.24	-2.00	-2.33	-1.15	-1.34	-0.46	-0.52
-0.1	-0.1	-0.26	-0.29	-2.10	-2.78	-1.21	-1.60	-0.48	-0.63
-0.2	-0.1	-0.29	-0.35	-2.19	-3.25	-1.27	-1.88	-0.50	-0.74
-0.2	-0.2	-0.32	-0.42	-2.27	-3.74	-1.32	-2.16	-0.52	-0.85
-0.2	-0.2	-0.34	-0.49	-2.33	-4.25	-1.37	-2.46	-0.52	-0.96
-0.3	-0.3	-0.37	-0.57	-2.39	-4.77	-1.41	-2.77	-0.53	-1.08
-0.3	-0.4	-0.40	-0.65	-2.45	-5.30	-1.45	-3.08	-0.53	-1.19
-0.4	-0.4	-0.42	-0.74	-2.50	-5.84	-1.49	-3.40	-0.53	-1.31
-0.4	-0.5	-0.45	-0.84	-2.55	-6.40	-1.52	-3.73	-0.53	-1.43
-0.5	-0.6	-0.48	-0.94	-2.60	-6.96	-1.56	-4.07	-0.53	-1.54
-0.5	-0.7	-0.50	-1.05	-2.65	-7.54	-1.59	-4.42	-0.53	-1.66
-0.6	-0.9	-0.53	-1.16	-2.70	-8.13	-1.63	-4.77	-0.53	-1.77
-0.6	-1.0	-0.55	-1.28	-2.75	-8.73	-1.66	-5.14	-0.53	-1.89
-0.7	-1.1	-0.58	-1.41	-2.79	-9.34	-1.69	-5.50	-0.53	-2.01
-0.8	-1.3	-0.61	-1.54	-2.84	-9.96	-1.72	-5.88	-0.53	-2.12
-0.8	-1.5	-0.63	-1.67	-2.88	-10.59	-1.75	-6.26	-0.53	-2.24
-0.9	-1.7	-0.66	-1.82	-2.92	-11.23	-1.78	-6.65	-0.53	-2.35
-1.0	-1.9	-0.69	-1.96	-2.96	-11.88	-1.81	-7.05	-0.53	-2.47
-1.1	-2.1	-0.71	-2.12	-3.00	-12.53	-1.84	-7.45	-0.53	-2.59
-1.1	-2.3	-0.74	-2.28	-3.04	-13.20	-1.86	-7.85	-0.53	-2.70
-1.2	-2.6	-0.77	-2.44	-3.08	-13.87	-1.89	-8.27	-0.53	-2.82
-1.3	-2.9	-0.79	-2.61	-3.11	-14.55	-1.91	-8.69	-0.53	-2.93
-1.4	-3.2	-0.82	-2.79	-3.15	-15.24	-1.94	-9.11	-0.53	-3.05
-1.5	-3.5	-0.84	-2.97	-3.18	-15.94	-1.96	-9.54	-0.53	-3.17
-1.6	-3.8	-0.87	-3.16	-3.21	-16.64	-1.98	-9.97	-0.53	-3.28
-1.7	-4.2	-0.90	-3.36	-3.25	-17.35	-2.00	-10.41	-0.53	-3.40
-1.8	-4.6	-0.92	-3.56	-3.27	-18.07	-2.02	-10.85	-0.53	-3.51
-1.9	-5.0	-0.95	-3.76	-3.30	-18.79	-2.04	-11.30	-0.53	-3.63
-2.0	-5.4	-0.98	-3.98	-3.33	-19.52	-2.06	-11.75	-0.53	-3.75
-2.1	-5.8	-1.00	-4.19	-3.36	-20.26	-2.07	-12.20	-0.53	-3.86
-2.2	-6.3	-1.03	-4.42	-3.38	-21.00	-2.09	-12.66	-0.53	-3.98
-2.3	-6.8	-1.06	-4.65	-3.40	-21.74	-2.10	-13.12	-0.53	-4.09
-2.4	-7.3	-1.08	-4.88	-3.43	-22.50	-2.12	-13.59	-0.53	-4.21
-2.6	-7.9	-1.11	-5.12	-3.45	-23.25	-2.13	-14.05	-0.53	-4.32
-2.7	-8.5	-1.14	-5.37	-3.47	-24.01	-2.14	-14.52	-0.53	-4.44
-2.8	-9.1	-1.16	-5.62	-3.48	-24.78	-2.15	-14.99	-0.53	-4.56
-2.9	-9.7	-1.19	-5.88	-3.50	-25.55	-2.16	-15.47	-0.53	-4.67
-3.1	-10.4	-1.21	-6.14	-3.52	-26.32	-2.17	-15.94	-0.53	-4.79
-3.2	-11.1	-1.24	-6.41	-3.53	-27.09	-2.18	-16.42	-0.53	-4.90
-3.3	-11.8	-1.27	-6.69	-3.54	-27.87	-2.18	-16.90	-0.53	-5.02
-3.5	-12.5	-1.29	-6.97	-3.56	-28.65	-2.19	-17.38	-0.53	-5.14
-3.6	-13.3	-1.32	-7.26	-3.57	-29.44	-2.20	-17.87	-0.53	-5.25
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.6	-13.3	-1.3	-7.3	-3.6	-29.4	-2.2	-17.9	-0.5	-5.3

Cantilever H = 13 ft

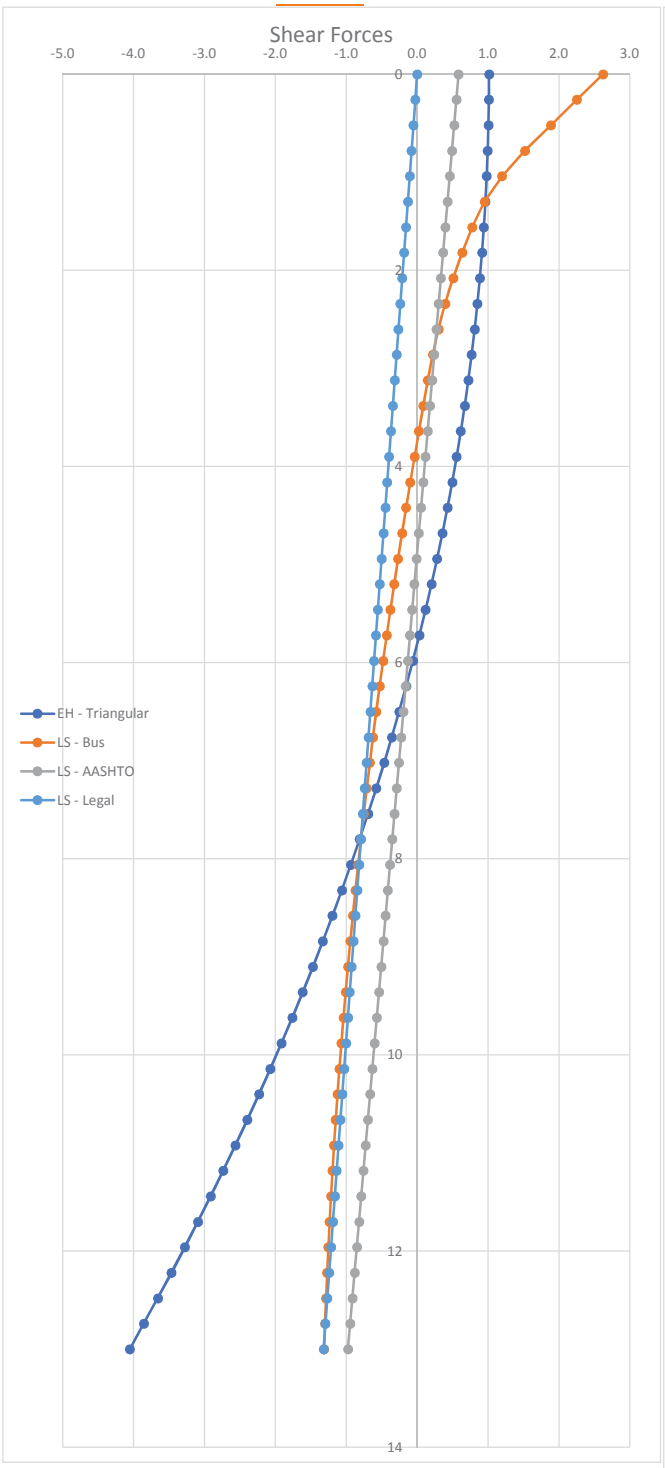


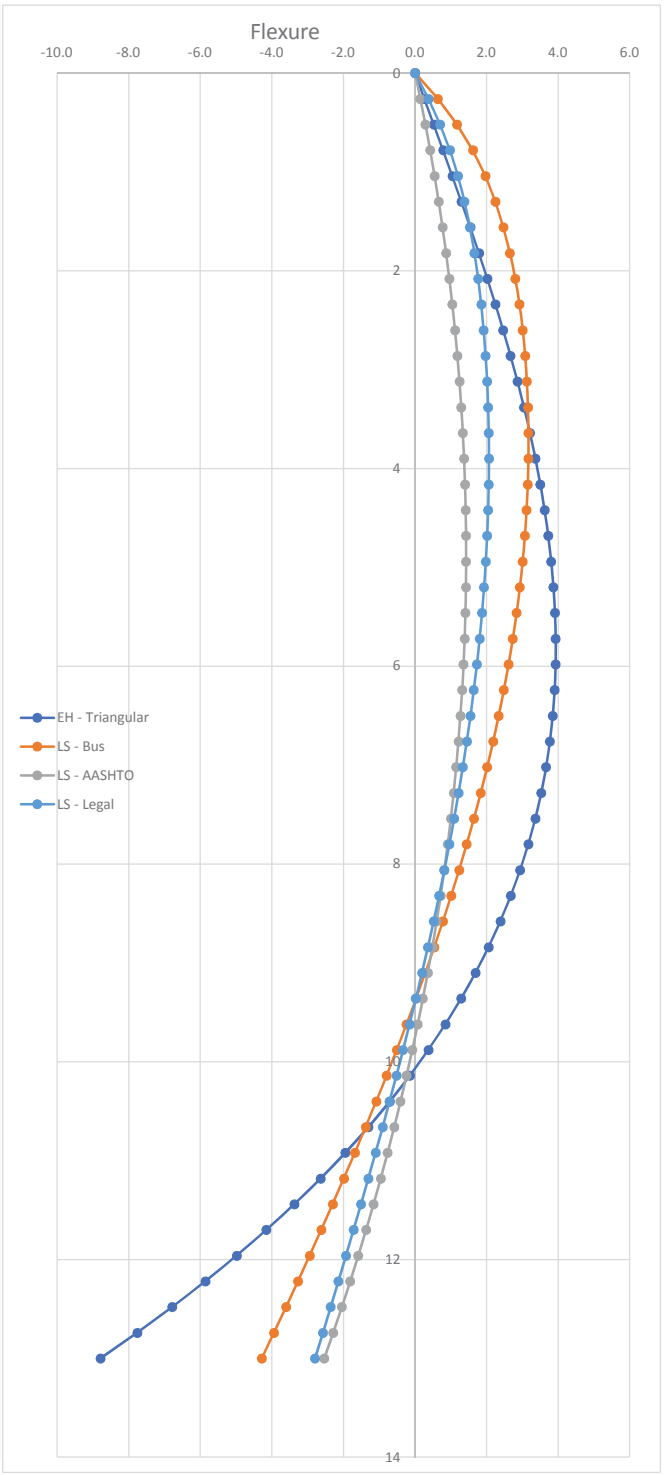


Pin Fix H = 13 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
1.0	0.0	0.59	0.00	2.62	0.00	1.55	0.00	0.46	0.00
1.0	0.3	0.55	0.15	2.25	0.63	1.35	0.38	0.38	0.11
1.0	0.5	0.52	0.29	1.89	1.17	1.15	0.70	0.30	0.20
1.0	0.8	0.49	0.42	1.52	1.62	0.95	0.97	0.23	0.27
1.0	1.0	0.46	0.54	1.20	1.97	0.77	1.20	0.17	0.32
1.0	1.3	0.43	0.66	0.95	2.24	0.63	1.38	0.12	0.36
0.9	1.5	0.40	0.77	0.78	2.47	0.53	1.53	0.07	0.38
0.9	1.8	0.37	0.87	0.64	2.65	0.45	1.66	0.03	0.39
0.9	2.0	0.34	0.96	0.51	2.80	0.37	1.76	-0.01	0.40
0.8	2.2	0.30	1.04	0.40	2.92	0.30	1.85	-0.03	0.39
0.8	2.5	0.27	1.12	0.30	3.01	0.24	1.92	-0.05	0.38
0.8	2.7	0.24	1.18	0.22	3.07	0.18	1.97	-0.06	0.37
0.7	2.9	0.21	1.24	0.15	3.12	0.13	2.01	-0.06	0.35
0.7	3.0	0.18	1.29	0.09	3.15	0.09	2.04	-0.06	0.33
0.6	3.2	0.15	1.33	0.02	3.17	0.04	2.06	-0.06	0.32
0.6	3.4	0.12	1.37	-0.04	3.17	0.00	2.06	-0.06	0.30
0.5	3.5	0.09	1.40	-0.10	3.15	-0.04	2.06	-0.06	0.28
0.4	3.6	0.05	1.41	-0.16	3.12	-0.09	2.04	-0.06	0.27
0.4	3.7	0.02	1.42	-0.21	3.07	-0.13	2.01	-0.06	0.25
0.3	3.8	-0.01	1.43	-0.27	3.00	-0.16	1.98	-0.06	0.24
0.2	3.9	-0.04	1.42	-0.32	2.93	-0.20	1.93	-0.06	0.22
0.1	3.9	-0.07	1.41	-0.38	2.84	-0.24	1.87	-0.06	0.20
0.0	3.9	-0.10	1.38	-0.43	2.73	-0.28	1.80	-0.06	0.19
-0.1	3.9	-0.13	1.35	-0.48	2.61	-0.31	1.73	-0.06	0.17
-0.2	3.9	-0.16	1.31	-0.53	2.48	-0.34	1.64	-0.06	0.15
-0.3	3.8	-0.20	1.27	-0.58	2.34	-0.38	1.55	-0.06	0.14
-0.4	3.8	-0.23	1.21	-0.62	2.18	-0.41	1.45	-0.06	0.12
-0.5	3.7	-0.26	1.15	-0.67	2.01	-0.44	1.33	-0.06	0.11
-0.6	3.5	-0.29	1.08	-0.71	1.83	-0.47	1.22	-0.06	0.09
-0.7	3.4	-0.32	1.00	-0.75	1.64	-0.50	1.09	-0.06	0.07
-0.8	3.2	-0.35	0.91	-0.79	1.44	-0.53	0.96	-0.06	0.06
-0.9	2.9	-0.38	0.82	-0.83	1.23	-0.55	0.82	-0.06	0.04
-1.1	2.7	-0.41	0.71	-0.87	1.01	-0.58	0.67	-0.06	0.02
-1.2	2.4	-0.44	0.60	-0.91	0.78	-0.60	0.52	-0.06	0.01
-1.3	2.1	-0.48	0.48	-0.94	0.54	-0.62	0.36	-0.06	-0.01
-1.5	1.7	-0.51	0.35	-0.98	0.29	-0.65	0.19	-0.06	-0.02
-1.6	1.3	-0.54	0.22	-1.01	0.03	-0.67	0.02	-0.06	-0.04
-1.8	0.9	-0.57	0.08	-1.04	-0.24	-0.69	-0.15	-0.06	-0.06
-1.9	0.4	-0.60	-0.08	-1.07	-0.51	-0.71	-0.33	-0.06	-0.07
-2.1	-0.1	-0.63	-0.24	-1.10	-0.79	-0.72	-0.52	-0.06	-0.09
-2.2	-0.7	-0.66	-0.41	-1.12	-1.08	-0.74	-0.71	-0.06	-0.11
-2.4	-1.3	-0.69	-0.58	-1.15	-1.38	-0.75	-0.90	-0.06	-0.12
-2.6	-1.9	-0.73	-0.77	-1.17	-1.68	-0.77	-1.10	-0.06	-0.14
-2.7	-2.6	-0.76	-0.96	-1.20	-1.99	-0.78	-1.30	-0.06	-0.15
-2.9	-3.4	-0.79	-1.16	-1.22	-2.30	-0.79	-1.51	-0.06	-0.17
-3.1	-4.2	-0.82	-1.37	-1.24	-2.62	-0.81	-1.72	-0.06	-0.19
-3.3	-5.0	-0.85	-1.59	-1.25	-2.94	-0.82	-1.93	-0.06	-0.20
-3.5	-5.9	-0.88	-1.81	-1.27	-3.27	-0.83	-2.14	-0.06	-0.22
-3.7	-6.8	-0.91	-2.04	-1.29	-3.60	-0.83	-2.36	-0.06	-0.24
-3.9	-7.8	-0.94	-2.29	-1.30	-3.94	-0.84	-2.57	-0.06	-0.25
-4.1	-8.8	-0.98	-2.54	-1.31	-4.28	-0.85	-2.79	-0.06	-0.27
1.0	3.9	0.6	1.4	2.6	3.2	1.5	2.1	0.5	0.4
-4.1	-8.8	-1.0	-2.5	-1.3	-4.3	-0.8	-2.8	-0.1	-0.3

Pin Fix H = 13 ft



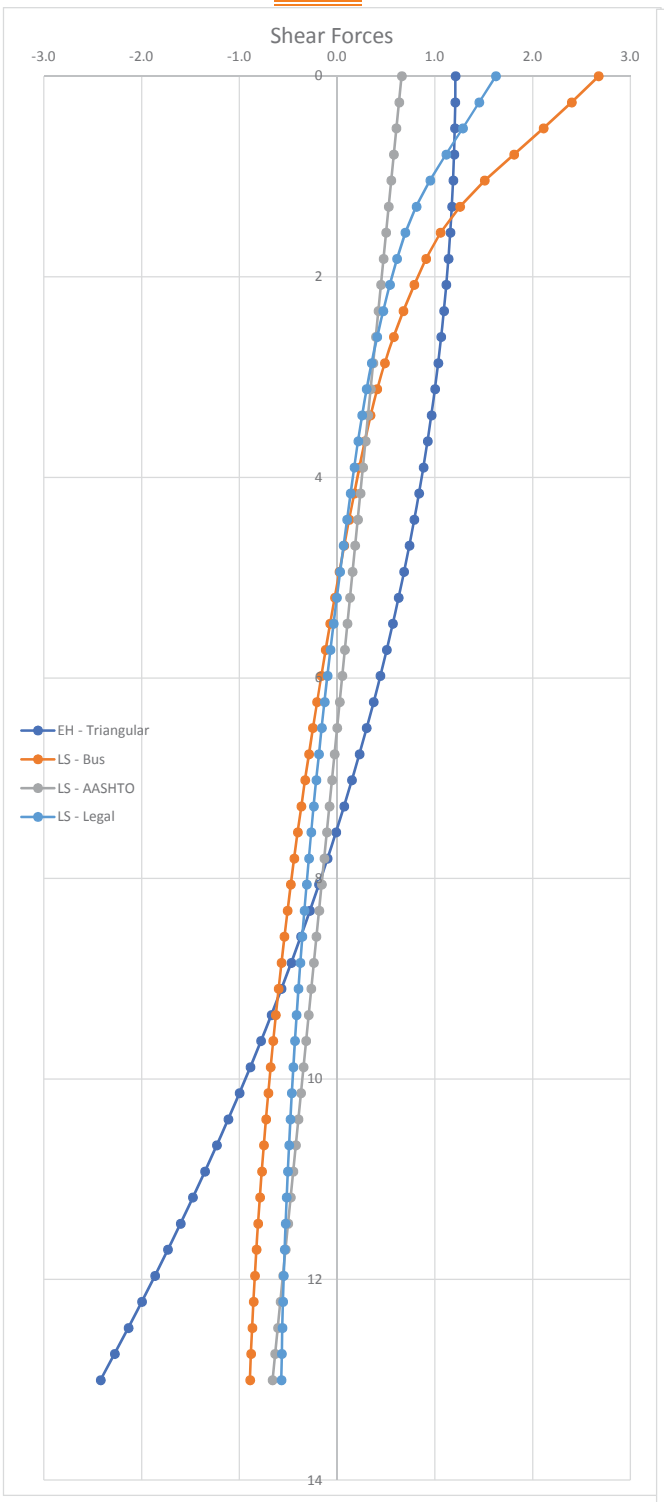


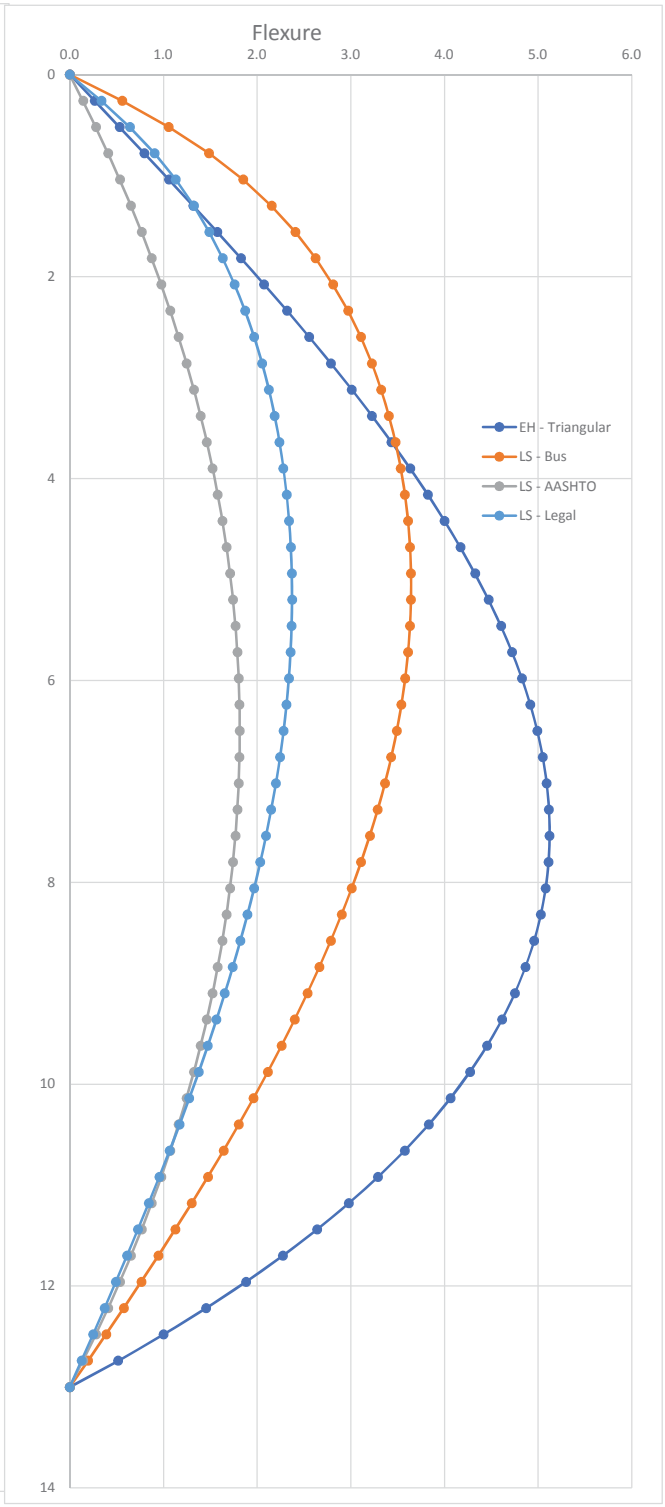
Pin-Pin H = 13 ft

EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
V	M	V	M	V	M	V	M	V	V
1.2	0.0	0.66	0.00	2.68	0.00	1.62	0.00	0.48	0.00
1.2	0.3	0.63	0.14	2.40	0.56	1.45	0.34	0.41	0.10
1.2	0.5	0.61	0.28	2.11	1.05	1.29	0.64	0.34	0.18
1.2	0.8	0.58	0.41	1.81	1.49	1.12	0.90	0.28	0.25
1.2	1.1	0.55	0.53	1.51	1.85	0.95	1.13	0.22	0.30
1.2	1.3	0.53	0.65	1.26	2.15	0.81	1.32	0.17	0.34
1.2	1.6	0.50	0.77	1.06	2.41	0.70	1.49	0.12	0.38
1.1	1.8	0.48	0.87	0.91	2.62	0.61	1.63	0.08	0.40
1.1	2.1	0.45	0.98	0.79	2.81	0.54	1.76	0.05	0.41
1.1	2.3	0.42	1.07	0.68	2.97	0.47	1.87	0.02	0.42
1.1	2.6	0.40	1.16	0.58	3.11	0.41	1.97	-0.01	0.42
1.0	2.8	0.37	1.25	0.49	3.23	0.35	2.05	-0.02	0.42
1.0	3.0	0.34	1.32	0.41	3.33	0.30	2.12	-0.04	0.41
1.0	3.2	0.32	1.40	0.34	3.41	0.26	2.19	-0.05	0.40
0.9	3.4	0.29	1.46	0.28	3.48	0.21	2.24	-0.05	0.39
0.9	3.6	0.26	1.52	0.23	3.53	0.18	2.28	-0.05	0.38
0.8	3.8	0.24	1.58	0.18	3.58	0.14	2.31	-0.05	0.37
0.8	4.0	0.21	1.63	0.12	3.61	0.10	2.34	-0.05	0.36
0.7	4.2	0.18	1.67	0.07	3.63	0.07	2.36	-0.05	0.35
0.7	4.3	0.16	1.71	0.02	3.64	0.03	2.37	-0.05	0.34
0.6	4.5	0.13	1.74	-0.02	3.64	0.00	2.37	-0.05	0.33
0.6	4.6	0.11	1.77	-0.07	3.63	-0.04	2.37	-0.05	0.32
0.5	4.7	0.08	1.79	-0.12	3.61	-0.07	2.36	-0.05	0.30
0.4	4.8	0.05	1.80	-0.16	3.58	-0.10	2.34	-0.05	0.29
0.4	4.9	0.03	1.81	-0.21	3.54	-0.13	2.31	-0.05	0.28
0.3	5.0	0.00	1.82	-0.25	3.49	-0.16	2.28	-0.05	0.27
0.2	5.0	-0.03	1.81	-0.29	3.43	-0.19	2.24	-0.05	0.26
0.2	5.1	-0.05	1.80	-0.33	3.36	-0.21	2.20	-0.05	0.25
0.1	5.1	-0.08	1.79	-0.37	3.29	-0.24	2.15	-0.05	0.24
0.0	5.1	-0.11	1.77	-0.40	3.20	-0.26	2.09	-0.05	0.23
-0.1	5.1	-0.13	1.74	-0.44	3.11	-0.29	2.03	-0.05	0.22
-0.2	5.1	-0.16	1.71	-0.47	3.01	-0.31	1.97	-0.05	0.21
-0.3	5.0	-0.18	1.67	-0.51	2.90	-0.33	1.90	-0.05	0.20
-0.4	5.0	-0.21	1.63	-0.54	2.79	-0.36	1.82	-0.05	0.19
-0.5	4.9	-0.24	1.58	-0.57	2.67	-0.38	1.74	-0.05	0.17
-0.6	4.8	-0.26	1.52	-0.60	2.54	-0.40	1.65	-0.05	0.16
-0.7	4.6	-0.29	1.46	-0.63	2.40	-0.41	1.57	-0.05	0.15
-0.8	4.5	-0.32	1.40	-0.65	2.26	-0.43	1.47	-0.05	0.14
-0.9	4.3	-0.34	1.32	-0.68	2.11	-0.45	1.38	-0.05	0.13
-1.0	4.1	-0.37	1.25	-0.70	1.96	-0.46	1.28	-0.05	0.12
-1.1	3.8	-0.40	1.16	-0.73	1.80	-0.48	1.17	-0.05	0.11
-1.2	3.6	-0.42	1.07	-0.75	1.64	-0.49	1.07	-0.05	0.10
-1.4	3.3	-0.45	0.98	-0.77	1.47	-0.50	0.96	-0.05	0.09
-1.5	3.0	-0.48	0.87	-0.79	1.30	-0.52	0.84	-0.05	0.08
-1.6	2.6	-0.50	0.77	-0.81	1.13	-0.53	0.73	-0.05	0.07
-1.7	2.3	-0.53	0.65	-0.83	0.95	-0.54	0.61	-0.05	0.05
-1.9	1.9	-0.55	0.53	-0.84	0.76	-0.55	0.49	-0.05	0.04
-2.0	1.5	-0.58	0.41	-0.86	0.58	-0.55	0.37	-0.05	0.03
-2.1	1.0	-0.61	0.28	-0.87	0.39	-0.56	0.25	-0.05	0.02
-2.3	0.5	-0.63	0.14	-0.88	0.20	-0.57	0.13	-0.05	0.01
-2.4	0.0	-0.66	0.00	-0.89	0.00	-0.57	0.00	-0.05	0.00
1.2	5.1	0.7	1.8	2.7	3.6	1.6	2.4	0.5	0.4
-2.4	0.0	-0.7	0.0	-0.9	0.0	-0.6	0.0	0.0	0.0

	EH - Triangular		LS-AASHTO		LS - Bus		LS - Legal		Normal Traffic	
	V	M	V	M	V	M	V	M	V	M
Pin Fix	4.06	8.79	0.98	2.54	2.62	4.28	1.55	2.79	0.46	0.40
Pin-Pin	2.42	5.12	0.66	1.82	2.68	3.64	1.62	2.37	0.48	0.42
Max	**4.06**	**8.79**	**0.98**	**2.54**	**2.68**	**4.28**	**1.62**	**2.79**	**0.48**	**0.42**

Pin-Pin H = 13 ft





Loading Analysis

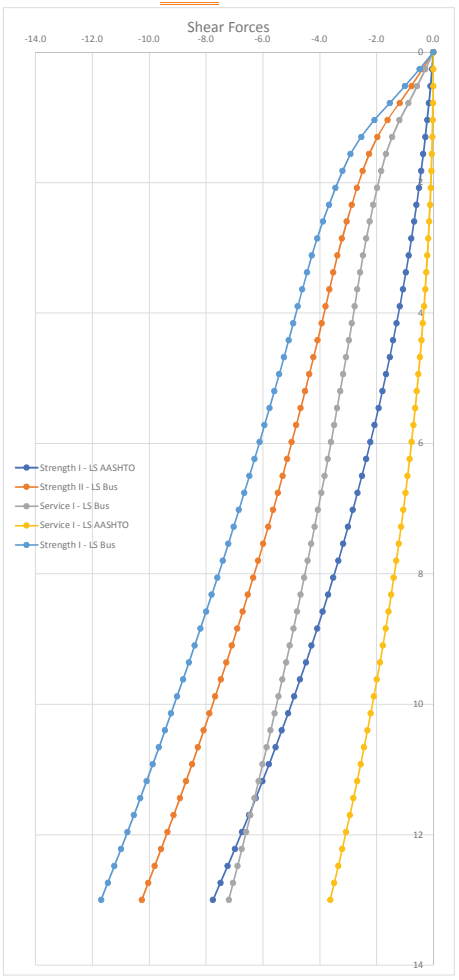
Load Combinations

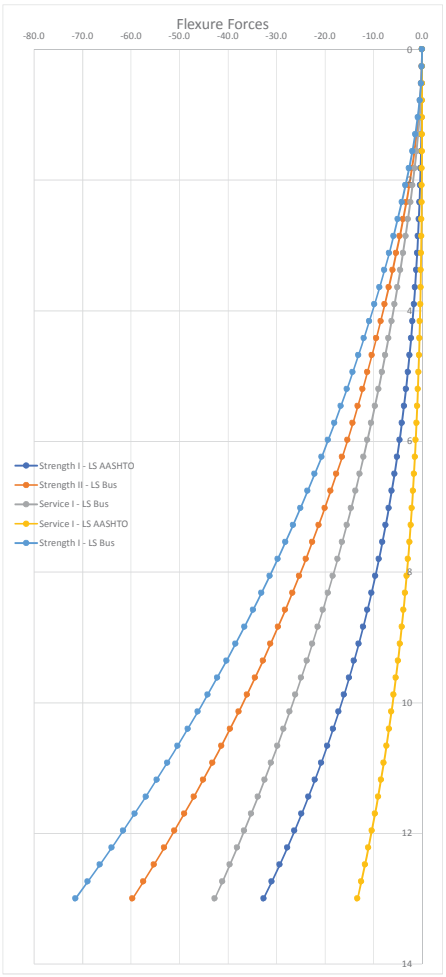
	EH	LS
Strength I	1.35	1.75
Strength II	1.35	1.35
Service I	1	1

Cantilever H = 13 ft

H	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal	
	V	M	V	M			V	M	V	M	V	M	V	M
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00		
0.26	0.0	0.0	-0.5	-0.1	-0.2	0.0	-0.4	0.0	0.00	0.00	-0.28	-0.03		
0.52	-0.1	0.0	-1.0	-0.2	-0.5	-0.1	-0.8	-0.2	-0.01	0.00	-0.57	-0.12		
0.78	-0.2	-0.1	-1.5	-0.5	-0.7	-0.2	-1.2	-0.4	-0.01	0.00	-0.88	-0.28		
1.04	-0.2	-0.1	-2.1	-0.9	-0.9	-0.4	-1.6	-0.7	-0.02	-0.01	-1.19	-0.51		
1.3	-0.3	-0.1	-2.5	-1.4	-1.2	-0.6	-2.0	-1.1	-0.04	-0.01	-1.46	-0.80		
1.56	-0.4	-0.2	-2.9	-2.0	-1.3	-0.9	-2.3	-1.6	-0.05	-0.02	-1.67	-1.15		
1.82	-0.4	-0.3	-3.2	-2.7	-1.5	-1.2	-2.5	-2.1	-0.07	-0.04	-1.84	-1.53		
2.08	-0.5	-0.4	-3.4	-3.4	-1.6	-1.6	-2.7	-2.6	-0.09	-0.05	-1.98	-1.95		
2.34	-0.6	-0.5	-3.7	-4.2	-1.7	-1.9	-2.9	-3.3	-0.12	-0.08	-2.12	-2.40		
2.6	-0.7	-0.7	-3.9	-5.0	-1.9	-2.3	-3.1	-3.9	-0.15	-0.11	-2.24	-2.88		
2.86	-0.8	-0.8	-4.1	-5.9	-2.0	-2.7	-3.2	-4.6	-0.18	-0.14	-2.36	-3.39		
3.12	-0.9	-1.0	-4.3	-6.8	-2.1	-3.2	-3.4	-5.3	-0.21	-0.18	-2.48	-3.92		
3.38	-1.0	-1.2	-4.5	-7.8	-2.2	-3.7	-3.5	-6.1	-0.25	-0.23	-2.58	-4.48		
3.64	-1.1	-1.4	-4.6	-8.8	-2.3	-4.2	-3.7	-6.9	-0.28	-0.29	-2.68	-5.06		
3.9	-1.2	-1.7	-4.8	-9.8	-2.4	-4.7	-3.8	-7.7	-0.33	-0.36	-2.77	-5.66		
4.16	-1.3	-2.0	-4.9	-10.9	-2.6	-5.2	-3.9	-8.5	-0.37	-0.44	-2.87	-6.28		
4.42	-1.4	-2.3	-5.1	-12.0	-2.7	-5.8	-4.1	-9.4	-0.42	-0.52	-2.97	-6.92		
4.68	-1.5	-2.6	-5.3	-13.1	-2.8	-6.4	-4.2	-10.3	-0.47	-0.62	-3.07	-7.59		
4.94	-1.7	-2.9	-5.4	-14.3	-2.9	-7.1	-4.4	-11.3	-0.52	-0.73	-3.18	-8.27		
5.2	-1.8	-3.3	-5.6	-15.5	-3.1	-7.7	-4.5	-12.3	-0.58	-0.85	-3.28	-8.98		
5.46	-1.9	-3.7	-5.8	-16.8	-3.2	-8.4	-4.7	-13.3	-0.64	-0.99	-3.39	-9.72		
5.72	-2.1	-4.2	-5.9	-18.0	-3.3	-9.1	-4.8	-14.3	-0.70	-1.13	-3.50	-10.47		
5.98	-2.2	-4.6	-6.1	-19.4	-3.5	-9.9	-5.0	-15.4	-0.77	-1.30	-3.61	-11.26		
6.24	-2.4	-5.1	-6.3	-20.7	-3.6	-10.7	-5.1	-16.5	-0.84	-1.47	-3.72	-12.06		
6.5	-2.5	-5.7	-6.5	-22.1	-3.8	-11.5	-5.3	-17.7	-0.91	-1.66	-3.83	-12.89		
6.76	-2.7	-6.2	-6.7	-23.6	-3.9	-12.3	-5.5	-18.8	-0.98	-1.87	-3.95	-13.75		
7.02	-2.8	-6.8	-6.8	-25.1	-4.1	-13.2	-5.6	-20.1	-1.06	-2.10	-4.06	-14.63		
7.28	-3.0	-7.5	-7.0	-26.6	-4.2	-14.1	-5.8	-21.3	-1.14	-2.34	-4.18	-15.53		
7.54	-3.2	-8.2	-7.2	-28.2	-4.4	-15.1	-6.0	-22.6	-1.22	-2.60	-4.30	-16.47		
7.8	-3.3	-8.9	-7.4	-29.8	-4.5	-16.0	-6.2	-24.0	-1.31	-2.87	-4.42	-17.43		
8.06	-3.5	-9.6	-7.6	-31.4	-4.7	-17.1	-6.3	-25.3	-1.40	-3.17	-4.54	-18.41		
8.32	-3.7	-10.4	-7.8	-33.1	-4.9	-18.1	-6.5	-26.7	-1.49	-3.49	-4.67	-19.43		
8.58	-3.9	-11.3	-8.0	-34.9	-5.0	-19.2	-6.7	-28.2	-1.58	-3.83	-4.80	-20.47		
8.84	-4.1	-12.2	-8.2	-36.6	-5.2	-20.3	-6.9	-29.7	-1.68	-4.19	-4.92	-21.54		
9.1	-4.3	-13.1	-8.4	-38.5	-5.4	-21.5	-7.1	-31.2	-1.78	-4.57	-5.05	-22.63		
9.36	-4.5	-14.0	-8.6	-40.3	-5.6	-22.7	-7.3	-32.8	-1.88	-4.97	-5.19	-23.76		
9.62	-4.7	-15.0	-8.8	-42.3	-5.8	-24.0	-7.5	-34.4	-1.99	-5.39	-5.32	-24.92		
9.88	-4.9	-16.1	-9.0	-44.2	-5.9	-25.2	-7.7	-36.1	-2.10	-5.84	-5.45	-26.10		
10.14	-5.1	-17.2	-9.2	-46.2	-6.1	-26.6	-7.9	-37.8	-2.21	-6.32	-5.59	-27.31		
10.4	-5.3	-18.4	-9.4	-48.3	-6.3	-27.9	-8.1	-39.6	-2.32	-6.81	-5.73	-28.56		
10.66	-5.6	-19.6	-9.7	-50.4	-6.5	-29.3	-8.3	-41.4	-2.44	-7.34	-5.87	-29.83		
10.92	-5.8	-20.8	-9.9	-52.5	-6.7	-30.8	-8.5	-43.2	-2.56	-7.89	-6.01	-31.14		
11.18	-6.0	-22.1	-10.1	-54.7	-6.9	-32.3	-8.7	-45.1	-2.68	-8.47	-6.15	-32.48		
11.44	-6.2	-23.4	-10.3	-57.0	-7.1	-33.8	-8.9	-47.1	-2.81	-9.07	-6.30	-33.85		
11.7	-6.5	-24.8	-10.5	-59.3	-7.3	-35.4	-9.1	-49.0	-2.94	-9.70	-6.44	-35.25		
11.96	-6.7	-26.3	-10.8	-61.6	-7.5	-37.1	-9.4	-51.1	-3.07	-10.36	-6.59	-36.68		
12.22	-7.0	-27.8	-11.0	-64.0	-7.8	-38.8	-9.6	-53.2	-3.21	-11.06	-6.74	-38.15		
12.48	-7.2	-29.4	-11.2	-66.4	-8.0	-40.5	-9.8	-55.3	-3.35	-11.78	-6.89	-39.65		
12.74	-7.5	-31.0	-11.5	-68.9	-8.2	-42.3	-10.0	-57.5	-3.49	-12.53	-7.04	-41.18		
13	-7.8	-32.7	-11.7	-71.5	-8.4	-44.1	-10.3	-59.7	-3.63	-13.31	-7.20	-42.75		
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	-7.8	-32.7	-11.7	-71.5	-8.4	-44.1	-10.3	-59.7	-3.6	-13.3	-7.2	-42.7		

Cantilever H = 13 ft

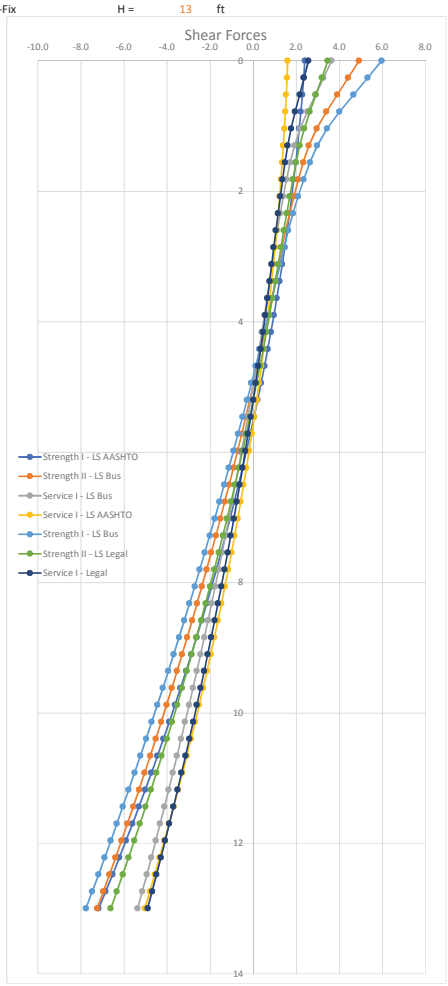


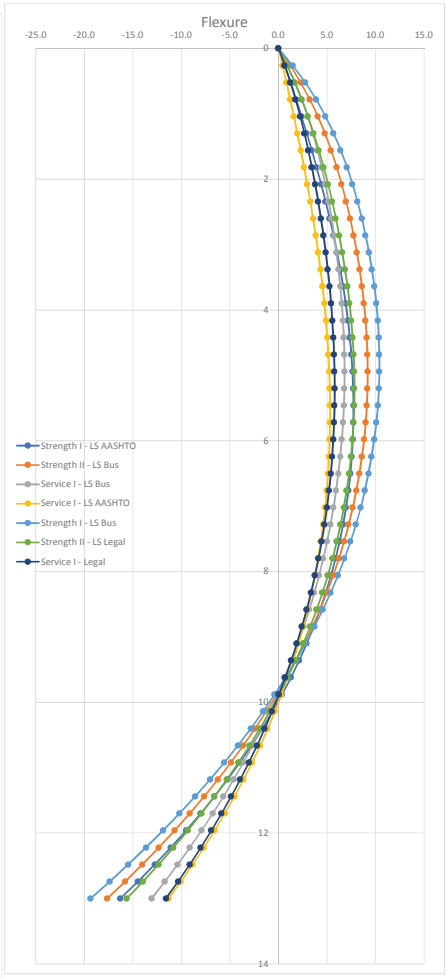


Pin Fix H = 13 ft

H	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal		Service I - Normal Traffic	
	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M
0	2.4	0.0	6.0	0.0	3.46	0.00	4.91	0.00	1.60	0.00	3.64	0.00	2.56	0.00	1.48	0.00
0.26	2.3	0.6	5.3	1.5	3.19	0.86	4.41	1.21	1.57	0.41	3.27	0.90	2.36	0.64	1.39	0.37
0.52	2.3	1.2	4.7	2.8	2.91	1.66	3.91	2.29	1.53	0.81	2.89	1.70	2.15	1.23	1.31	0.72
0.78	2.2	1.8	4.0	3.9	2.63	2.38	3.40	3.24	1.49	1.21	2.52	2.40	1.94	1.76	1.23	1.05
1.04	2.1	2.4	3.4	4.9	2.37	3.02	2.94	4.06	1.44	1.59	2.18	3.01	1.75	2.24	1.15	1.36
1.3	2.1	2.9	3.0	5.7	2.16	3.61	2.58	4.78	1.39	1.96	1.91	3.54	1.60	2.68	1.08	1.65
1.56	2.0	3.4	2.6	6.4	1.99	4.15	2.32	5.42	1.34	2.31	1.72	4.01	1.47	3.07	1.01	1.92
1.82	1.9	3.9	2.3	7.0	1.84	4.65	2.09	5.99	1.28	2.65	1.55	4.44	1.36	3.44	0.94	2.18
2.08	1.8	4.4	2.1	7.6	1.69	5.10	1.88	6.51	1.22	2.98	1.39	4.82	1.25	3.78	0.88	2.41
2.34	1.7	4.9	1.8	8.1	1.55	5.53	1.68	6.97	1.15	3.28	1.25	5.16	1.15	4.09	0.82	2.63
2.6	1.6	5.3	1.6	8.6	1.41	5.91	1.50	7.38	1.08	3.58	1.11	5.47	1.05	4.38	0.76	2.84
2.86	1.5	5.7	1.4	9.0	1.28	6.26	1.33	7.75	1.01	3.85	0.99	5.74	0.95	4.64	0.71	3.03
3.12	1.3	6.0	1.2	9.3	1.15	6.58	1.18	8.08	0.93	4.10	0.87	5.98	0.85	4.87	0.66	3.21
3.38	1.2	6.4	1.1	9.6	1.02	6.86	1.02	8.36	0.85	4.33	0.76	6.19	0.76	5.08	0.61	3.37
3.64	1.1	6.7	0.9	9.9	0.89	7.11	0.86	8.61	0.76	4.54	0.64	6.38	0.66	5.27	0.55	3.53
3.9	1.0	6.9	0.7	10.1	0.75	7.32	0.70	8.81	0.67	4.73	0.52	6.53	0.56	5.42	0.50	3.66
4.16	0.8	7.2	0.5	10.2	0.61	7.50	0.54	8.97	0.58	4.89	0.40	6.65	0.45	5.56	0.43	3.78
4.42	0.7	7.4	0.3	10.3	0.46	7.64	0.37	9.09	0.48	5.03	0.27	6.73	0.34	5.66	0.37	3.89
4.68	0.5	7.5	0.1	10.4	0.31	7.74	0.19	9.16	0.38	5.14	0.14	6.79	0.23	5.73	0.29	3.97
4.94	0.4	7.6	-0.1	10.4	0.16	7.80	0.02	9.19	0.27	5.23	0.01	6.81	0.12	5.78	0.22	4.04
5.2	0.2	7.7	-0.3	10.3	0.00	7.82	-0.16	9.17	0.16	5.29	-0.12	6.79	0.00	5.79	0.14	4.09
5.46	0.0	7.7	-0.5	10.2	-0.16	7.80	-0.35	9.11	0.05	5.31	-0.26	6.74	-0.12	5.78	0.06	4.11
5.72	-0.1	7.7	-0.7	10.1	-0.33	7.74	-0.54	8.99	-0.07	5.31	-0.40	6.66	-0.24	5.73	-0.03	4.12
5.98	-0.3	7.7	-0.9	9.9	-0.50	7.63	-0.73	8.83	-0.19	5.28	-0.54	6.54	-0.37	5.65	-0.12	4.10
6.24	-0.5	7.6	-1.1	9.6	-0.67	7.48	-0.92	8.61	-0.32	5.21	-0.68	6.38	-0.50	5.54	-0.22	4.05
6.5	-0.7	7.4	-1.4	9.3	-0.85	7.28	-1.12	8.35	-0.45	5.11	-0.83	6.18	-0.63	5.39	-0.32	3.98
6.76	-0.9	7.2	-1.6	8.9	-1.03	7.03	-1.32	8.03	-0.58	4.98	-0.98	5.95	-0.77	5.21	-0.42	3.89
7.02	-1.1	7.0	-1.8	8.5	-1.22	6.74	-1.53	7.66	-0.72	4.81	-1.13	5.67	-0.90	4.99	-0.53	3.76
7.28	-1.3	6.6	-2.0	8.0	-1.41	6.40	-1.74	7.23	-0.86	4.60	-1.29	5.36	-1.05	4.74	-0.64	3.61
7.54	-1.5	6.3	-2.3	7.4	-1.61	6.01	-1.95	6.75	-1.01	4.36	-1.45	5.00	-1.19	4.45	-0.75	3.43
7.8	-1.7	5.9	-2.5	6.8	-1.80	5.56	-2.17	6.22	-1.16	4.08	-1.61	4.61	-1.34	4.12	-0.87	3.22
8.06	-1.9	5.4	-2.7	6.1	-2.01	5.07	-2.39	5.63	-1.32	3.75	-1.77	4.17	-1.49	3.75	-1.00	2.98
8.32	-2.2	4.9	-3.0	5.4	-2.21	4.52	-2.61	4.98	-1.48	3.39	-1.93	3.69	-1.64	3.35	-1.13	2.70
8.58	-2.4	4.3	-3.2	4.6	-2.42	3.92	-2.84	4.27	-1.64	2.99	-2.10	3.16	-1.80	2.90	-1.26	2.39
8.84	-2.6	3.6	-3.4	3.7	-2.64	3.26	-3.07	3.50	-1.81	2.54	-2.27	2.59	-1.95	2.41	-1.39	2.05
9.1	-2.9	2.9	-3.7	2.8	-2.86	2.54	-3.30	2.67	-1.98	2.05	-2.45	1.98	-2.12	1.89	-1.53	1.67
9.36	-3.1	2.1	-3.9	1.8	-3.08	1.77	-3.54	1.78	-2.15	1.51	-2.62	1.32	-2.28	1.31	-1.68	1.25
9.62	-3.4	1.3	-4.2	0.7	-3.31	0.94	-3.78	0.83	-2.33	0.93	-2.80	0.62	-2.45	0.70	-1.82	0.80
9.88	-3.6	0.4	-4.5	-0.4	-3.54	0.05	-4.03	-0.18	-2.52	0.30	-2.98	-0.14	-2.62	0.04	-1.98	0.30
10.14	-3.9	-0.6	-4.7	-1.6	-3.77	-0.90	-4.28	-1.26	-2.70	-0.38	-3.17	-0.94	-2.79	-0.66	-2.13	-0.23
10.4	-4.2	-1.7	-5.0	-2.8	-4.01	-1.91	-4.53	-2.41	-2.89	-1.11	-3.35	-1.78	-2.97	-1.41	-2.29	-0.81
10.66	-4.4	-2.8	-5.2	-4.2	-4.25	-2.98	-4.78	-3.62	-3.09	-1.89	-3.54	-2.68	-3.15	-2.21	-2.46	-1.43
10.92	-4.7	-4.0	-5.5	-5.6	-4.50	-4.12	-5.04	-4.90	-3.29	-2.72	-3.74	-3.63	-3.33	-3.05	-2.63	-2.09
11.18	-5.0	-5.2	-5.8	-7.0	-4.75	-5.32	-5.31	-6.24	-3.49	-3.60	-3.93	-4.62	-3.52	-3.94	-2.80	-2.79
11.44	-5.3	-6.6	-6.1	-8.6	-5.00	-6.59	-5.57	-7.66	-3.70	-4.53	-4.13	-5.67	-3.71	-4.88	-2.97	-3.54
11.7	-5.6	-8.0	-6.3	-10.2	-5.26	-7.92	-5.84	-9.14	-3.91	-5.52	-4.33	-6.77	-3.90	-5.87	-3.16	-4.34
11.96	-5.9	-9.5	-6.6	-11.9	-5.53	-9.33	-6.12	-10.70	-4.13	-6.57	-4.53	-7.92	-4.09	-6.91	-3.34	-5.18
12.22	-6.2	-11.1	-6.9	-13.6	-5.79	-10.80	-6.39	-12.32	-4.35	-7.67	-4.74	-9.13	-4.29	-8.00	-3.53	-6.08
12.48	-6.5	-12.7	-7.2	-15.5	-6.06	-12.34	-6.68	-14.02	-4.57	-8.83	-4.94	-10.39	-4.49	-9.14	-3.72	-7.02
12.74	-6.9	-14.5	-7.5	-17.4	-6.34	-13.95	-6.96	-15.79	-4.80	-10.05	-5.16	-11.70	-4.70	-10.33	-3.92	-8.01
13	-7.2	-16.3	-7.8	-19.4	-6.62	-15.64	-7.25	-17.64	-5.03	-11.32	-5.37	-13.07	-4.90	-11.58	-4.12	-9.06
	2.4	7.7	6.0	10.4	3.5	7.8	4.9	9.2	1.6	5.3	3.6	6.8	2.6	5.8	1.5	4.1
	-7.2	-16.3	-7.8	-19.4	-6.6	-15.6	-7.2	-17.6	-5.0	-11.3	-5.4	-13.1	-4.9	-11.6	-4.1	-9.1

Pin-Fix H = 13 ft





Pin-Pin H = 13 ft

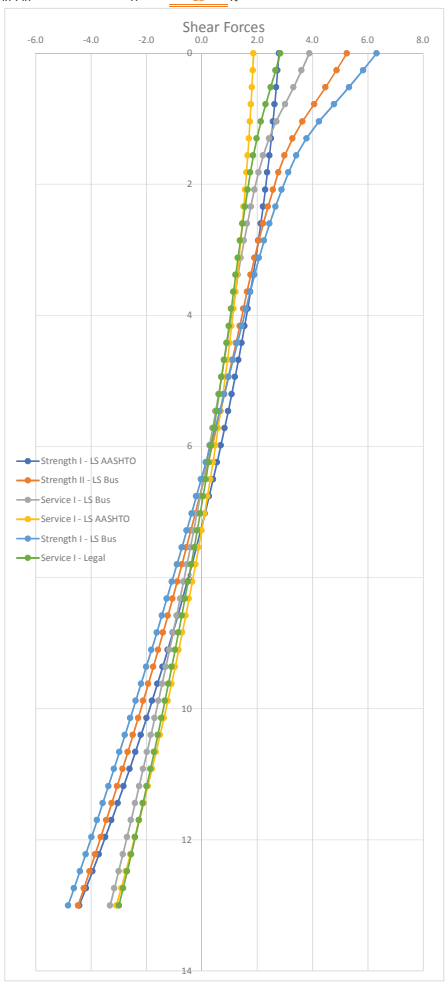
	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal	
H	V	M	V	M	V	M	V	M	V	M	V	M	V	M
0	2.8	0.0	6.3	0.0	3.83	0.00	5.2	0.0	1.87	0.00	3.89	0.00	2.83	0.00
0.26	2.7	0.6	5.8	1.3	3.60	0.82	4.9	1.1	1.84	0.41	3.61	0.82	2.66	0.60
0.52	2.7	1.2	5.3	2.6	3.36	1.58	4.5	2.1	1.81	0.81	3.32	1.59	2.49	1.17
0.78	2.6	1.8	4.8	3.7	3.12	2.30	4.1	3.1	1.78	1.21	3.01	2.28	2.31	1.70
1.04	2.6	2.4	4.2	4.7	2.89	2.96	3.6	3.9	1.74	1.59	2.70	2.91	2.14	2.19
1.3	2.5	2.9	3.8	5.5	2.68	3.57	3.3	4.7	1.70	1.97	2.43	3.47	1.99	2.64
1.56	2.4	3.5	3.4	6.3	2.51	4.14	3.0	5.4	1.66	2.34	2.22	3.98	1.86	3.06
1.82	2.4	4.0	3.1	7.1	2.36	4.67	2.8	6.0	1.61	2.70	2.05	4.45	1.75	3.46
2.08	2.3	4.5	2.9	7.7	2.24	5.18	2.6	6.6	1.57	3.05	1.91	4.89	1.66	3.84
2.34	2.2	5.0	2.7	8.3	2.11	5.66	2.4	7.1	1.51	3.39	1.77	5.29	1.56	4.19
2.6	2.1	5.5	2.4	8.9	1.99	6.11	2.2	7.6	1.46	3.72	1.64	5.67	1.47	4.52
2.86	2.0	5.9	2.3	9.4	1.87	6.53	2.1	8.1	1.40	4.03	1.52	6.01	1.39	4.84
3.12	2.0	6.4	2.1	9.9	1.76	6.93	1.9	8.6	1.34	4.33	1.41	6.34	1.30	5.13
3.38	1.9	6.8	1.9	10.3	1.65	7.31	1.8	9.0	1.28	4.62	1.31	6.63	1.22	5.41
3.64	1.8	7.2	1.7	10.7	1.54	7.66	1.6	9.3	1.22	4.90	1.21	6.91	1.14	5.67
3.9	1.7	7.6	1.6	11.1	1.43	7.98	1.5	9.7	1.15	5.16	1.11	7.17	1.06	5.91
4.16	1.5	7.9	1.4	11.4	1.32	8.29	1.4	10.0	1.08	5.40	1.01	7.40	0.98	6.14
4.42	1.4	8.3	1.3	11.7	1.20	8.56	1.2	10.3	1.00	5.63	0.91	7.61	0.89	6.34
4.68	1.3	8.6	1.1	12.0	1.09	8.82	1.1	10.5	0.92	5.84	0.81	7.80	0.81	6.53
4.94	1.2	8.8	1.0	12.2	0.97	9.04	1.0	10.8	0.84	6.04	0.71	7.97	0.72	6.70
5.2	1.1	9.1	0.8	12.4	0.85	9.24	0.8	11.0	0.76	6.21	0.60	8.12	0.63	6.85
5.46	1.0	9.3	0.6	12.6	0.72	9.41	0.7	11.1	0.68	6.37	0.50	8.24	0.53	6.97
5.72	0.8	9.5	0.5	12.7	0.59	9.56	0.5	11.3	0.59	6.51	0.39	8.33	0.44	7.08
5.98	0.7	9.7	0.3	12.8	0.46	9.67	0.4	11.4	0.49	6.63	0.28	8.41	0.34	7.17
6.24	0.6	9.8	0.1	12.8	0.33	9.76	0.2	11.4	0.40	6.73	0.17	8.46	0.24	7.23
6.5	0.4	9.9	0.0	12.8	0.19	9.82	0.1	11.5	0.30	6.81	0.06	8.48	0.14	7.27
6.76	0.3	10.0	-0.2	12.8	0.06	9.85	-0.1	11.5	0.20	6.86	-0.06	8.48	0.04	7.29
7.02	0.1	10.0	-0.4	12.8	-0.08	9.84	-0.2	11.4	0.10	6.89	-0.18	8.46	-0.06	7.29
7.28	0.0	10.0	-0.5	12.7	-0.23	9.81	-0.4	11.3	-0.01	6.91	-0.29	8.40	-0.17	7.27
7.54	-0.2	10.0	-0.7	12.5	-0.37	9.74	-0.6	11.2	-0.12	6.89	-0.41	8.33	-0.28	7.22
7.8	-0.4	9.9	-0.9	12.3	-0.52	9.65	-0.7	11.1	-0.23	6.85	-0.54	8.22	-0.39	7.14
8.06	-0.5	9.9	-1.1	12.1	-0.67	9.51	-0.9	10.9	-0.34	6.79	-0.66	8.09	-0.50	7.05
8.32	-0.7	9.7	-1.3	11.9	-0.83	9.35	-1.1	10.7	-0.46	6.70	-0.78	7.93	-0.61	6.93
8.58	-0.9	9.5	-1.4	11.6	-0.98	9.15	-1.2	10.5	-0.58	6.59	-0.91	7.75	-0.73	6.78
8.84	-1.0	9.3	-1.6	11.2	-1.14	8.92	-1.4	10.2	-0.71	6.45	-1.04	7.53	-0.84	6.61
9.1	-1.2	9.1	-1.8	10.9	-1.30	8.65	-1.6	9.8	-0.83	6.28	-1.17	7.29	-0.96	6.41
9.36	-1.4	8.8	-2.0	10.4	-1.47	8.34	-1.8	9.5	-0.96	6.08	-1.30	7.02	-1.09	6.18
9.62	-1.6	8.5	-2.2	10.0	-1.63	8.00	-1.9	9.1	-1.09	5.85	-1.43	6.72	-1.21	5.93
9.88	-1.8	8.1	-2.4	9.5	-1.80	7.63	-2.1	8.6	-1.23	5.60	-1.57	6.39	-1.33	5.65
10.14	-2.0	7.7	-2.6	8.9	-1.97	7.21	-2.3	8.1	-1.37	5.31	-1.70	6.03	-1.46	5.34
10.4	-2.2	7.2	-2.8	8.3	-2.15	6.76	-2.5	7.6	-1.51	4.99	-1.84	5.64	-1.59	5.01
10.66	-2.4	6.7	-3.0	7.7	-2.33	6.26	-2.7	7.0	-1.65	4.65	-1.98	5.22	-1.72	4.64
10.92	-2.6	6.2	-3.2	7.0	-2.51	5.73	-2.9	6.4	-1.80	4.27	-2.12	4.77	-1.86	4.25
11.18	-2.8	5.6	-3.4	6.3	-2.69	5.16	-3.1	5.8	-1.95	3.85	-2.26	4.28	-1.99	3.82
11.44	-3.0	4.9	-3.6	5.5	-2.87	4.55	-3.3	5.1	-2.10	3.41	-2.41	3.77	-2.13	3.37
11.7	-3.3	4.2	-3.8	4.7	-3.06	3.90	-3.5	4.4	-2.26	2.93	-2.56	3.22	-2.27	2.89
11.96	-3.5	3.5	-4.0	3.9	-3.25	3.20	-3.6	3.6	-2.42	2.42	-2.70	2.64	-2.41	2.37
12.22	-3.7	2.7	-4.2	3.0	-3.44	2.47	-3.9	2.7	-2.58	1.87	-2.85	2.03	-2.55	1.83
12.48	-3.9	1.8	-4.4	2.0	-3.64	1.69	-4.1	1.9	-2.74	1.28	-3.00	1.39	-2.70	1.25
12.74	-4.2	0.9	-4.6	1.0	-3.84	0.87	-4.3	1.0	-2.91	0.66	-3.16	0.71	-2.84	0.64
13	-4.4	0.0	-4.8	0.0	-4.04	0.00	-4.5	0.0	-3.08	0.00	-3.31	0.00	-2.99	0.00
	2.8	10.0	6.3	12.8	3.8	9.8	5.2	11.5	1.9	6.9	3.9	8.5	2.8	7.3
	-4.4	0.0	-4.8	0.0	-4.0	0.0	-4.5	0.0	-3.1	0.0	-3.3	0.0	-3.0	0.0

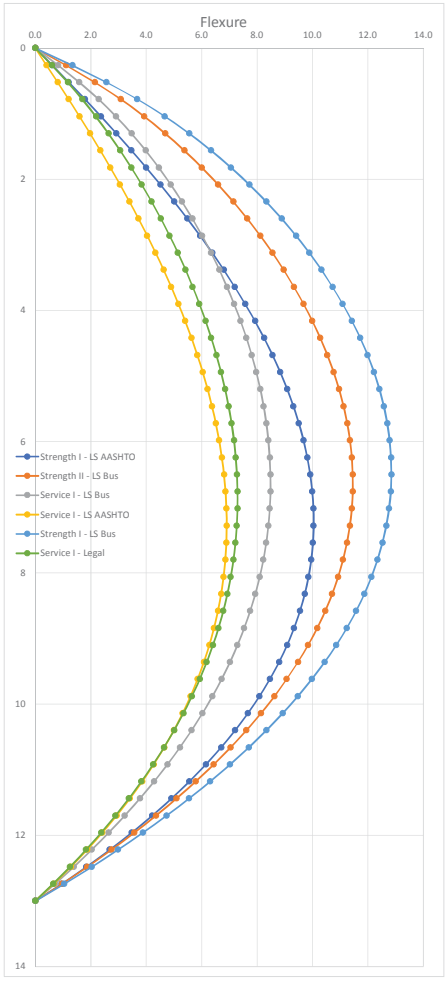
Loading Summary

	Strength I - LS AASHTO		Strength I - LS Bus		Strength II - LS Legal		Strength II - LS Bus		Service I - LS AASHTO		Service I - LS Bus		Service I - Legal		Service I - Normal	
	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M
Pin Fix	7.18	16.30	7.77	19.35	6.62	15.64	7.25	17.64	5.03	11.32	5.37	13.07	4.90	11.58	4.12	9.06
Pin-Pin	4.42	10.04	6.32	12.85	4.04	9.85	5.25	11.45	3.08	6.91	3.89	8.48	2.99	7.29		
Max	**7.18**	**16.30**	**7.77**	**19.35**	**6.62**	**15.64**	**7.25**	**17.64**	**5.03**	**11.32**	**5.37**	**13.07**	**4.90**	**11.58**	**4.12**	**9.06**

	Str I			Str II	Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	**7.2**	**7.8**	**6.6**	**7.2**	**5.0**	**5.4**	**4.9**	**4.1**
Moment	**16.3**	**19.4**	**15.6**	**17.6**	**11.3**	**13.1**	**11.6**	**9.1**

Pin-Pin H = 13 ft





C/D Ratios

Shear and Moment

Capacities

Concrete Wall per ACI 318 Chapter 22

f'c_nom	2500	psi - Assumed nominal compressive strength
ϕcond	0.75	Condition Adjustment Factor
ϕshear	0.6	
ϕmoment	0.6	
f'c	1875	psi - Design compressive strength
d	18	in - Wall thickness at section under consideration
b	12	in - Unit width of wall
S	648	in3 - uncracked section modulus
Pwall	2545	lbs - axial load at mid height of wall
Pwalk	215	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	12.78	psi - axial stress at mid height of wall

Shear

Vn = 4/3*sqrt(f'c)*b*d

Vn	V
12.5	7.48

Flexure

Mn = 5*sqrt(f'c)*S (ACI 318 CH22)

fru = 5*sqrt(f'c) + Pu/A Add in compressive stress due to axial force

fru	Mn	phi*M
229.3	12.4	7.43

Brick Masonry Wall

f'm_nom	1000	psi - Assumed nominal compressive strength
fr_nom	30	psi - Assumed nominal modulus of rupture (tensile strength)
ϕcond	0.6	Condition Adjustment Factor
ϕshear	0.6	
ϕmoment	0.8	
f'm	600	psi - Design nominal compressive strength
fr	18	psi - Design nominal modulus of rupture (tensile strength)
d	24	in - Wall thickness
b	12	in - Wall width
An	288	in2
S	1152	in3 - uncracked section modulus
Pwall	2808	lbs - axial load at mid height of wall
Pwalk	215	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	10.50	psi - axial stress at mid height of wall

Shear

Vn = min	| 3.8*An*sqrt(f'm)	(1)	ACI 530
	| 300*An	(2)	
	| 90*An + 0.45*Nu	(3)	

Vn (1)	Vn (2)	Vn (3)	Vn	phi*V
26.8	86.4	25.92	25.92	15.55

Flexure

Mn = fru*S ACI 530

fru = fr + Pu/A

fru	Mn	phi*M
28.5	2.7	2.19

Stone Masonry Wall

ϕcond	0.6	
ϕshear	0.6	
ϕmoment	0.8	
f'm	600	psi - Design nominal compressive strength
fr	18	psi - Design nominal modulus of rupture (tensile strength)
d	24	in - Wall thickness
b	12	in - Wall width
An	288	in2
S	1152	in3 - uncracked section modulus
Scr	576	cracked section modulus
Pwall	3770	lbs - axial load at mid height of wall
Pwalk	239	lbs - axial load on top of wall from 4" thick x 10 foot wide sidewalk
f_axial	13.92	psi - axial stress at mid height of wall

Shear

Vn = min	| 3.8*An*sqrt(f'm)	(1)	ACI 530
	| 300*An	(2)	
	| 90*An + 0.45*Nu	(3)	

Vn (1)	Vn (2)	Vn (3)	Vn	phi*V
26.8	86.4	25.92	25.92	15.55

Flexure

Mn = fru*S ACI 530

fru = fr + Pu/A

fru	Mn	phi*M
31.9	3.1	2.45

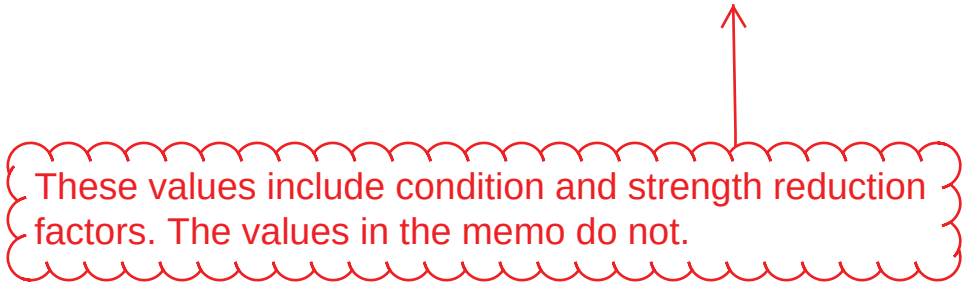
	phi*Vn	phi*Mn			
Concrete Wall	7.48	7.43	for d =	18	in
Brick Masonry	15.55	2.19	for d =	24	in
Stone Masonry	15.55	2.45	for d =	24	in

Factored Load Summary H = 13

	Str I			Str II	Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	7.2	7.8	6.6	7.2	5.0	5.4	4.9	4.1
Moment	16.3	19.4	15.6	17.6	11.3	13.1	11.6	9.1

C/D Ratios - Concrete

	Str I		Str II		Ser I			
	LS AASHTO	Bus	Legal	Bus	LS AASHTO	Bus	Legal	Normal Traffic
Shear	**1.04**	**0.96**	**1.13**	**1.03**	**1.49**	**1.39**	**1.53**	**1.82**
Moment	**0.46**	**0.38**	**0.48**	**0.42**	**0.66**	**0.57**	**0.64**	**0.82**
Bearing	0.27	0.23	0.28	0.25	0.37	0.32	0.36	0.44
Sliding	0.28	0.26	0.30	0.28	0.44	0.41	0.45	0.54



SINGLE-SPAN BEAM ANALYSIS

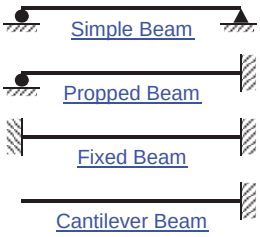
For Simple, Propped, Fixed, or Cantilever Beams

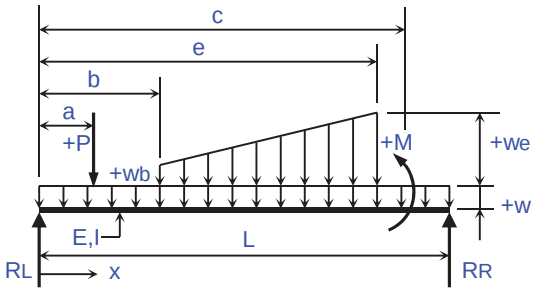
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - EH		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	13.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:

	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.0000	13.0000	0.7800
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:

	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:

	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	1.01 k	RR =	4.06 k
ML =	N.A.	MR =	-8.79 ft-k

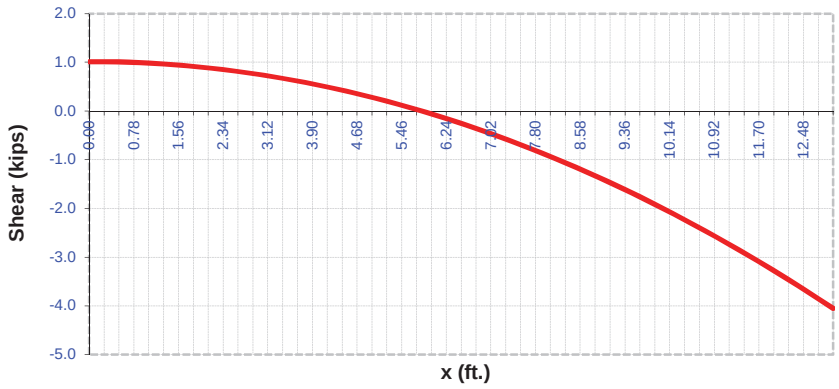
Maximum Moments:

+M(max) =	3.93 ft-k	@ x =	5.81 ft.
-M(max) =	-8.79 ft-k	@ x =	13.00 ft.

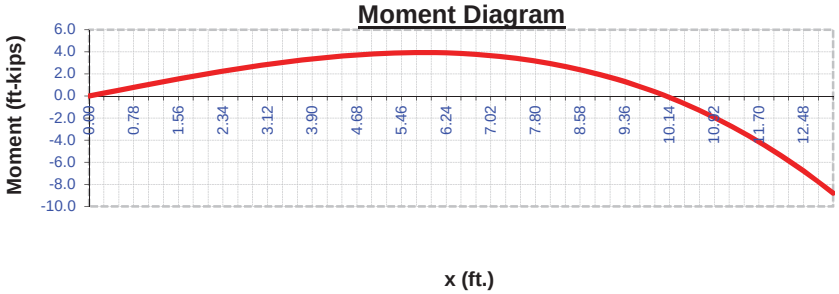
Maximum Deflections:

-Δ(max) =	-5.101 in.	@ x =	5.81 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/31		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	1.01	0.00	-6.5457	0.0000
2	0.2600	1.01	0.26	-6.5300	-0.3562
3	0.5200	1.01	0.53	-6.4829	-0.7106
4	0.7800	1.00	0.79	-6.4047	-1.0616
5	1.0400	0.98	1.04	-6.2957	-1.4076
6	1.3000	0.96	1.30	-6.1562	-1.7467
7	1.5600	0.94	1.54	-5.9869	-2.0775
8	1.8200	0.91	1.79	-5.7885	-2.3982
9	2.0800	0.88	2.02	-5.5617	-2.7074
10	2.3400	0.85	2.24	-5.3076	-3.0035
11	2.6000	0.81	2.46	-5.0271	-3.2850
12	2.8600	0.77	2.67	-4.7215	-3.5505
13	3.1200	0.72	2.86	-4.3921	-3.7987
14	3.3800	0.67	3.04	-4.0403	-4.0284
15	3.6400	0.62	3.21	-3.6678	-4.2384
16	3.9000	0.56	3.36	-3.2761	-4.4275
17	4.1600	0.49	3.50	-2.8672	-4.5949
18	4.4200	0.43	3.62	-2.4430	-4.7395
19	4.6800	0.36	3.72	-2.0055	-4.8607
20	4.9400	0.28	3.80	-1.5569	-4.9577
21	5.2000	0.20	3.87	-1.0997	-5.0301
22	5.4600	0.12	3.91	-0.6361	-5.0774
23	5.7200	0.03	3.93	-0.1689	-5.0993
24	5.9800	-0.06	3.93	0.2993	-5.0958
25	6.2400	-0.15	3.90	0.7657	-5.0667
26	6.5000	-0.25	3.84	1.2273	-5.0125
27	6.7600	-0.36	3.77	1.6811	-4.9332
28	7.0200	-0.46	3.66	2.1237	-4.8296
29	7.2800	-0.58	3.52	2.5520	-4.7022
30	7.5400	-0.69	3.36	2.9624	-4.5520
31	7.8000	-0.81	3.16	3.3514	-4.3800
32	8.0600	-0.93	2.94	3.7152	-4.1874
33	8.3200	-1.06	2.68	4.0501	-3.9759
34	8.5800	-1.19	2.38	4.3520	-3.7469
35	8.8400	-1.33	2.06	4.6169	-3.5026
36	9.1000	-1.47	1.69	4.8405	-3.2449
37	9.3600	-1.61	1.29	5.0186	-2.9762
38	9.6200	-1.76	0.85	5.1467	-2.6992
39	9.8800	-1.91	0.37	5.2201	-2.4167
40	10.1400	-2.07	-0.14	5.2342	-2.1318
41	10.4000	-2.23	-0.70	5.1842	-1.8478
42	10.6600	-2.40	-1.30	5.0650	-1.5684
43	10.9200	-2.56	-1.95	4.8716	-1.2975
44	11.1800	-2.74	-2.64	4.5987	-1.0393
45	11.4400	-2.91	-3.37	4.2411	-0.7982
46	11.7000	-3.09	-4.15	3.7932	-0.5790
47	11.9600	-3.28	-4.98	3.2495	-0.3868
48	12.2200	-3.47	-5.86	2.6042	-0.2270
49	12.4800	-3.66	-6.78	1.8516	-0.1052
50	12.7400	-3.86	-7.76	0.9855	-0.0274
51	13.0000	-4.06	-8.79	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

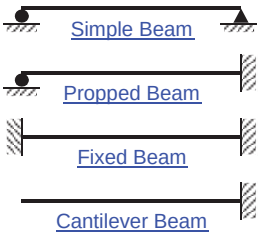
For Simple, Propped, Fixed, or Cantilever Beams

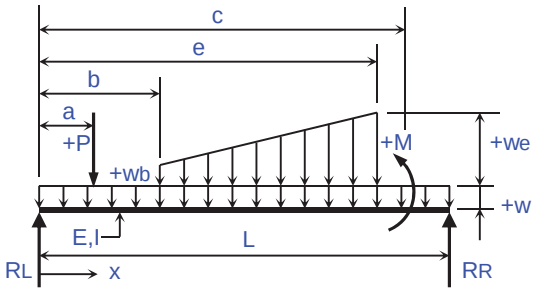
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS AASHTO	
Job Number:		Originator:	SW	Checker:

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	13.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = 0.1200 kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:				
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	0.59 k	RR =	0.98 k
ML =	N.A.	MR =	-2.54 ft-k

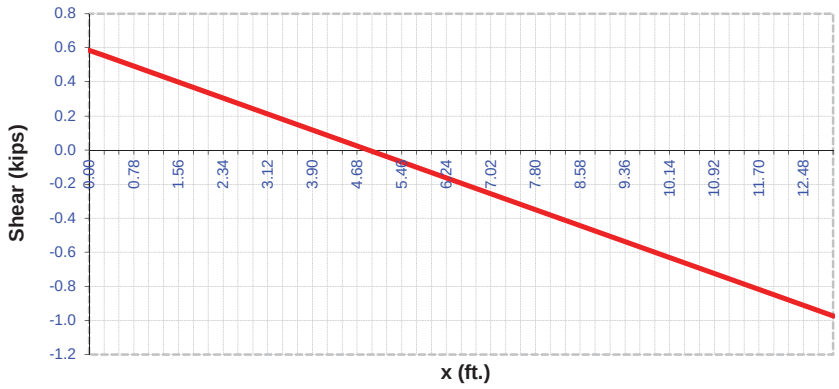
Maximum Moments:

+M(max) =	1.43 ft-k	@ x =	4.88 ft.
-M(max) =	-2.54 ft-k	@ x =	13.00 ft.

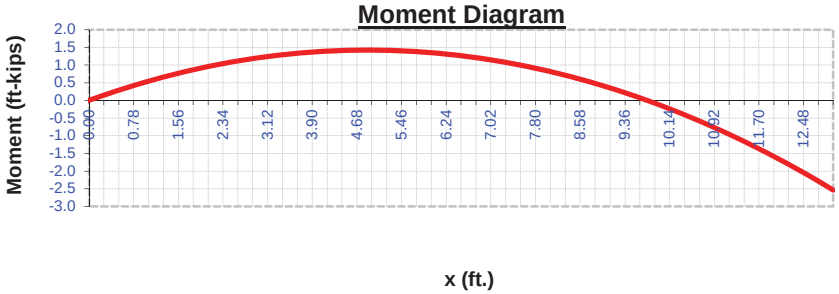
Maximum Deflections:

-Δ(max) =	-1.782 in.	@ x =	5.48 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/88		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	0.59	0.00	-2.5176	0.0000
2	0.2600	0.55	0.15	-2.5087	-0.1369
3	0.5200	0.52	0.29	-2.4826	-0.2729
4	0.7800	0.49	0.42	-2.4404	-0.4070
5	1.0400	0.46	0.54	-2.3829	-0.5384
6	1.3000	0.43	0.66	-2.3111	-0.6663
7	1.5600	0.40	0.77	-2.2261	-0.7899
8	1.8200	0.37	0.87	-2.1287	-0.9085
9	2.0800	0.34	0.96	-2.0200	-1.0215
10	2.3400	0.30	1.04	-1.9009	-1.1283
11	2.6000	0.27	1.12	-1.7724	-1.2284
12	2.8600	0.24	1.18	-1.6354	-1.3212
13	3.1200	0.21	1.24	-1.4909	-1.4063
14	3.3800	0.18	1.29	-1.3399	-1.4834
15	3.6400	0.15	1.33	-1.1833	-1.5521
16	3.9000	0.12	1.37	-1.0221	-1.6122
17	4.1600	0.09	1.40	-0.8573	-1.6634
18	4.4200	0.05	1.41	-0.6899	-1.7055
19	4.6800	0.02	1.42	-0.5208	-1.7385
20	4.9400	-0.01	1.43	-0.3509	-1.7622
21	5.2000	-0.04	1.42	-0.1813	-1.7767
22	5.4600	-0.07	1.41	-0.0128	-1.7820
23	5.7200	-0.10	1.38	0.1534	-1.7782
24	5.9800	-0.13	1.35	0.3165	-1.7654
25	6.2400	-0.16	1.31	0.4755	-1.7438
26	6.5000	-0.20	1.27	0.6294	-1.7137
27	6.7600	-0.23	1.21	0.7773	-1.6753
28	7.0200	-0.26	1.15	0.9181	-1.6291
29	7.2800	-0.29	1.08	1.0510	-1.5755
30	7.5400	-0.32	1.00	1.1750	-1.5148
31	7.8000	-0.35	0.91	1.2890	-1.4477
32	8.0600	-0.38	0.82	1.3922	-1.3746
33	8.3200	-0.41	0.71	1.4835	-1.2963
34	8.5800	-0.44	0.60	1.5620	-1.2133
35	8.8400	-0.48	0.48	1.6267	-1.1264
36	9.1000	-0.51	0.35	1.6767	-1.0364
37	9.3600	-0.54	0.22	1.7110	-0.9441
38	9.6200	-0.57	0.08	1.7286	-0.8504
39	9.8800	-0.60	-0.08	1.7285	-0.7562
40	10.1400	-0.63	-0.24	1.7099	-0.6625
41	10.4000	-0.66	-0.41	1.6717	-0.5703
42	10.6600	-0.69	-0.58	1.6129	-0.4808
43	10.9200	-0.73	-0.77	1.5326	-0.3950
44	11.1800	-0.76	-0.96	1.4299	-0.3143
45	11.4400	-0.79	-1.16	1.3037	-0.2397
46	11.7000	-0.82	-1.37	1.1531	-0.1727
47	11.9600	-0.85	-1.59	0.9771	-0.1146
48	12.2200	-0.88	-1.81	0.7747	-0.0668
49	12.4800	-0.91	-2.04	0.5451	-0.0307
50	12.7400	-0.94	-2.29	0.2872	-0.0080
51	13.0000	-0.98	-2.54	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

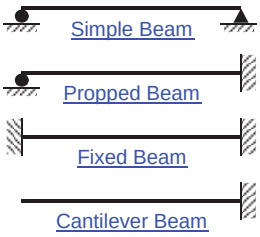
For Simple, Propped, Fixed, or Cantilever Beams

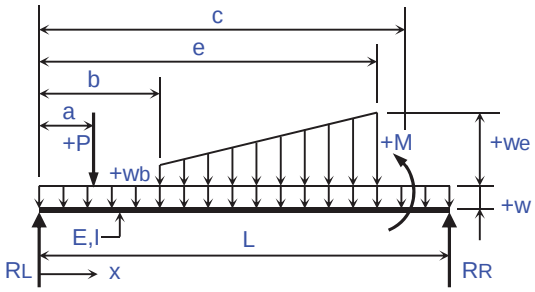
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Bus		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	13.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	1.4145	0.7500	1.4145
#2:	0.7500	1.4145	1.5000	0.5865
#3:	1.5000	0.5865	3.0000	0.2530
#4:	3.0000	0.2530	13.0000	0.0460
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	2.62 k	RR =	1.31 k
ML =	N.A.	MR =	-4.28 ft-k

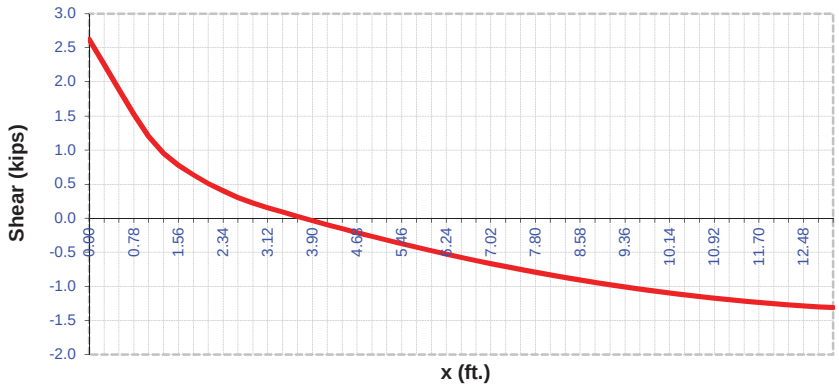
Maximum Moments:

+M(max) =	3.17 ft-k	@ x =	3.74 ft.
-M(max) =	-4.28 ft-k	@ x =	13.00 ft.

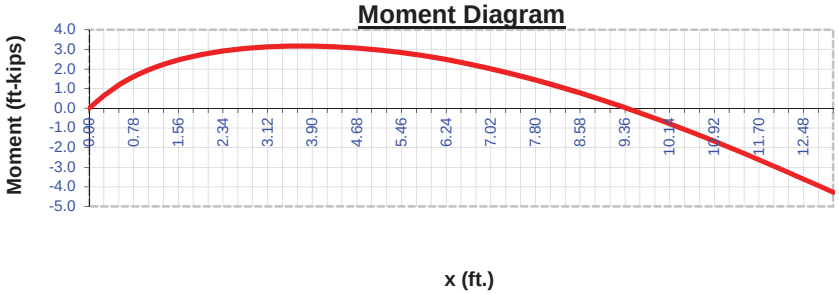
Maximum Deflections:

-Δ(max) =	-3.686 in.	@ x =	5.11 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/42		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	2.62	0.00	-5.9612	0.0000
2	0.2600	2.25	0.63	-5.9225	-0.3239
3	0.5200	1.89	1.17	-5.8139	-0.6437
4	0.7800	1.52	1.62	-5.6468	-0.9560
5	1.0400	1.20	1.97	-5.4325	-1.2579
6	1.3000	0.95	2.24	-5.1809	-1.5470
7	1.5600	0.78	2.47	-4.8996	-1.8216
8	1.8200	0.64	2.65	-4.5942	-2.0802
9	2.0800	0.51	2.80	-4.2691	-2.3216
10	2.3400	0.40	2.92	-3.9282	-2.5448
11	2.6000	0.30	3.01	-3.5749	-2.7492
12	2.8600	0.22	3.07	-3.2123	-2.9340
13	3.1200	0.15	3.12	-2.8428	-3.0989
14	3.3800	0.09	3.15	-2.4687	-3.2435
15	3.6400	0.02	3.17	-2.0918	-3.3677
16	3.9000	-0.04	3.17	-1.7142	-3.4713
17	4.1600	-0.10	3.15	-1.3377	-3.5544
18	4.4200	-0.16	3.12	-0.9643	-3.6171
19	4.6800	-0.21	3.07	-0.5957	-3.6595
20	4.9400	-0.27	3.00	-0.2337	-3.6821
21	5.2000	-0.32	2.93	0.1199	-3.6851
22	5.4600	-0.38	2.84	0.4634	-3.6692
23	5.7200	-0.43	2.73	0.7952	-3.6349
24	5.9800	-0.48	2.61	1.1138	-3.5828
25	6.2400	-0.53	2.48	1.4174	-3.5138
26	6.5000	-0.58	2.34	1.7046	-3.4287
27	6.7600	-0.62	2.18	1.9740	-3.3285
28	7.0200	-0.67	2.01	2.2241	-3.2141
29	7.2800	-0.71	1.83	2.4535	-3.0867
30	7.5400	-0.75	1.64	2.6608	-2.9473
31	7.8000	-0.79	1.44	2.8448	-2.7973
32	8.0600	-0.83	1.23	3.0042	-2.6379
33	8.3200	-0.87	1.01	3.1377	-2.4706
34	8.5800	-0.91	0.78	3.2443	-2.2967
35	8.8400	-0.94	0.54	3.3228	-2.1178
36	9.1000	-0.98	0.29	3.3720	-1.9353
37	9.3600	-1.01	0.03	3.3910	-1.7511
38	9.6200	-1.04	-0.24	3.3787	-1.5666
39	9.8800	-1.07	-0.51	3.3343	-1.3837
40	10.1400	-1.10	-0.79	3.2567	-1.2041
41	10.4000	-1.12	-1.08	3.1451	-1.0296
42	10.6600	-1.15	-1.38	2.9988	-0.8622
43	10.9200	-1.17	-1.68	2.8168	-0.7037
44	11.1800	-1.20	-1.99	2.5985	-0.5561
45	11.4400	-1.22	-2.30	2.3431	-0.4213
46	11.7000	-1.24	-2.62	2.0501	-0.3016
47	11.9600	-1.25	-2.94	1.7188	-0.1988
48	12.2200	-1.27	-3.27	1.3487	-0.1151
49	12.4800	-1.29	-3.60	0.9391	-0.0526
50	12.7400	-1.30	-3.94	0.4897	-0.0135
51	13.0000	-1.31	-4.28	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

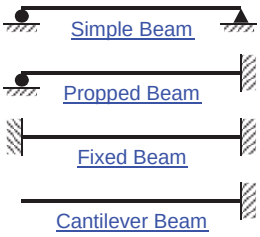
For Simple, Propped, Fixed, or Cantilever Beams

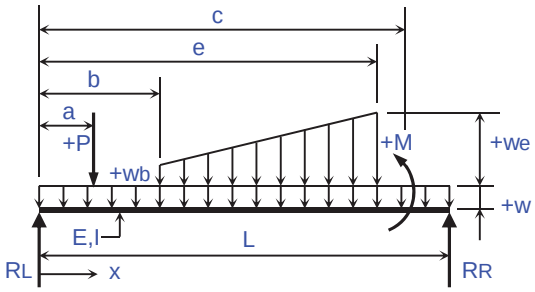
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Legal		
Job Number:		Originator:	SW	Checker:	

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	13.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:

	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.7700	0.7500	0.7700
#2:	0.7500	0.7700	1.5000	0.3500
#3:	1.5000	0.3500	3.0000	0.1800
#4:	3.0000	0.1800	13.0000	0.0200
#5:				
#6:				
#7:				
#8:				

Point Loads:

	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:

	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	1.55 k	RR =	0.85 k
ML =	N.A.	MR =	-2.79 ft-k

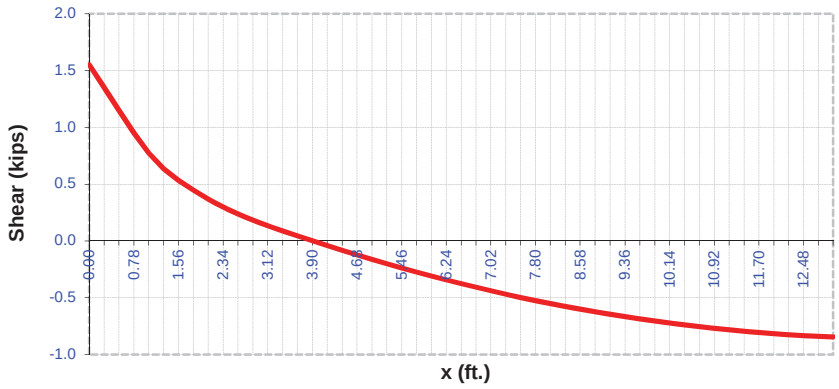
Maximum Moments:

+M(max) =	2.06 ft-k	@ x =	3.89 ft.
-M(max) =	-2.79 ft-k	@ x =	13.00 ft.

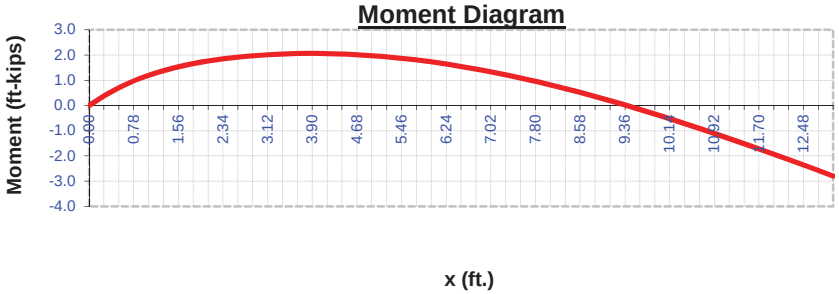
Maximum Deflections:

-Δ(max) =	-2.405 in.	@ x =	5.14 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/65		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	1.55	0.00	-3.8275	0.0000
2	0.2600	1.35	0.38	-3.8045	-0.2080
3	0.5200	1.15	0.70	-3.7397	-0.4136
4	0.7800	0.95	0.97	-3.6393	-0.6146
5	1.0400	0.77	1.20	-3.5095	-0.8094
6	1.3000	0.63	1.38	-3.3556	-0.9964
7	1.5600	0.53	1.53	-3.1820	-1.1745
8	1.8200	0.45	1.66	-2.9919	-1.3427
9	2.0800	0.37	1.76	-2.7880	-1.5001
10	2.3400	0.30	1.85	-2.5727	-1.6461
11	2.6000	0.24	1.92	-2.3481	-1.7801
12	2.8600	0.18	1.97	-2.1162	-1.9017
13	3.1200	0.13	2.01	-1.8787	-2.0105
14	3.3800	0.09	2.04	-1.6370	-2.1062
15	3.6400	0.04	2.06	-1.3927	-2.1887
16	3.9000	0.00	2.06	-1.1470	-2.2579
17	4.1600	-0.04	2.06	-0.9013	-2.3136
18	4.4200	-0.09	2.04	-0.6571	-2.3561
19	4.6800	-0.13	2.01	-0.4154	-2.3852
20	4.9400	-0.16	1.98	-0.1776	-2.4014
21	5.2000	-0.20	1.93	0.0551	-2.4047
22	5.4600	-0.24	1.87	0.2814	-2.3955
23	5.7200	-0.28	1.80	0.5004	-2.3742
24	5.9800	-0.31	1.73	0.7108	-2.3411
25	6.2400	-0.34	1.64	0.9116	-2.2969
26	6.5000	-0.38	1.55	1.1017	-2.2421
27	6.7600	-0.41	1.45	1.2801	-2.1772
28	7.0200	-0.44	1.33	1.4458	-2.1029
29	7.2800	-0.47	1.22	1.5979	-2.0199
30	7.5400	-0.50	1.09	1.7355	-1.9291
31	7.8000	-0.53	0.96	1.8576	-1.8312
32	8.0600	-0.55	0.82	1.9635	-1.7271
33	8.3200	-0.58	0.67	2.0522	-1.6177
34	8.5800	-0.60	0.52	2.1231	-1.5039
35	8.8400	-0.62	0.36	2.1754	-1.3868
36	9.1000	-0.65	0.19	2.2084	-1.2673
37	9.3600	-0.67	0.02	2.2213	-1.1467
38	9.6200	-0.69	-0.15	2.2136	-1.0258
39	9.8800	-0.71	-0.33	2.1846	-0.9060
40	10.1400	-0.72	-0.52	2.1338	-0.7883
41	10.4000	-0.74	-0.71	2.0605	-0.6740
42	10.6600	-0.75	-0.90	1.9644	-0.5643
43	10.9200	-0.77	-1.10	1.8448	-0.4605
44	11.1800	-0.78	-1.30	1.7015	-0.3638
45	11.4400	-0.79	-1.51	1.5338	-0.2756
46	11.7000	-0.81	-1.72	1.3416	-0.1972
47	11.9600	-0.82	-1.93	1.1244	-0.1299
48	12.2200	-0.83	-2.14	0.8819	-0.0752
49	12.4800	-0.83	-2.36	0.6138	-0.0344
50	12.7400	-0.84	-2.57	0.3199	-0.0088
51	13.0000	-0.85	-2.79	0.0000	0.0000

SINGLE-SPAN BEAM ANALYSIS

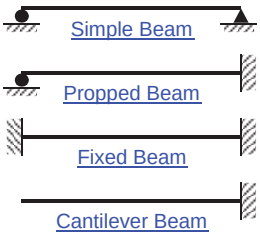
For Simple, Propped, Fixed, or Cantilever Beams

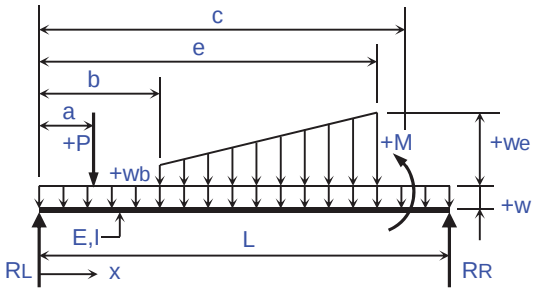
Job Name:	1st Ave. Areaways Assessment	Subject:	Pin Fix Loading - LS Normal Traffic	
Job Number:		Originator:	SW	Checker:

Input Data:

Beam Data:

Span Type?	Propped	
Span, L =	13.0000	ft.
Modulus, E =	3600	ksi
Inertia, I =	5.00	in.^4





Nomenclature

Beam Loadings:

Full Uniform:

w = kips/ft.

Distributed:	Start b (ft.)	Wb (kips/ft.)	End e (ft.)	We (kips/ft.)
#1:	0.0000	0.3400	3.1000	0.0000
#2:				
#3:				
#4:				
#5:				
#6:				
#7:				
#8:				

Point Loads:	a (ft.)	P (kips)
#1:		
#2:		
#3:		
#4:		
#5:		
#6:		
#7:		
#8:		
#9:		
#10:		
#11:		
#12:		
#13:		
#14:		
#15:		

Moments:	c (ft.)	M (ft-kips)
#1:		
#2:		
#3:		
#4:		

Results:

Reactions:

RL =	0.46 k	RR =	0.06 k
ML =	N.A.	MR =	-0.27 ft-k

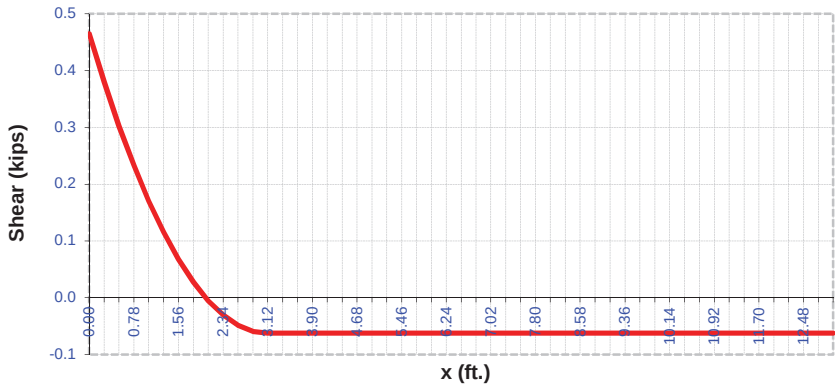
Maximum Moments:

+M(max) =	0.40 ft-k	@ x =	2.04 ft.
-M(max) =	-0.27 ft-k	@ x =	13.00 ft.

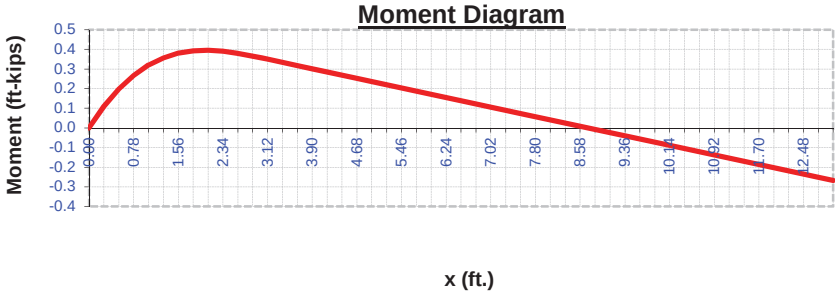
Maximum Deflections:

-Δ(max) =	-0.314 in.	@ x =	4.43 ft.
+Δ(max) =	0.000 in.	@ x =	0.00 ft.
Δ(ratio) =	L/496		

Shear Diagram



Moment Diagram



Tabulation of Single-Span Beam Shear, Moment, Slope, and Deflection for 50 Equal Segments					
Point #	x (ft.)	Shear (k)	Moment (ft-k)	Slope or Rotation (deg.)	Deflection (in.)
1	0.0000	0.46	0.00	-0.6316	0.0000
2	0.2600	0.38	0.11	-0.6249	-0.0343
3	0.5200	0.30	0.20	-0.6063	-0.0678
4	0.7800	0.23	0.27	-0.5784	-0.1001
5	1.0400	0.17	0.32	-0.5432	-0.1307
6	1.3000	0.12	0.36	-0.5028	-0.1592
7	1.5600	0.07	0.38	-0.4587	-0.1854
8	1.8200	0.03	0.39	-0.4126	-0.2091
9	2.0800	-0.01	0.40	-0.3656	-0.2303
10	2.3400	-0.03	0.39	-0.3187	-0.2489
11	2.6000	-0.05	0.38	-0.2727	-0.2650
12	2.8600	-0.06	0.37	-0.2283	-0.2787
13	3.1200	-0.06	0.35	-0.1857	-0.2899
14	3.3800	-0.06	0.33	-0.1450	-0.2989
15	3.6400	-0.06	0.32	-0.1062	-0.3058
16	3.9000	-0.06	0.30	-0.0694	-0.3105
17	4.1600	-0.06	0.28	-0.0345	-0.3134
18	4.4200	-0.06	0.27	-0.0015	-0.3143
19	4.6800	-0.06	0.25	0.0295	-0.3136
20	4.9400	-0.06	0.24	0.0586	-0.3111
21	5.2000	-0.06	0.22	0.0857	-0.3072
22	5.4600	-0.06	0.20	0.1109	-0.3018
23	5.7200	-0.06	0.19	0.1342	-0.2952
24	5.9800	-0.06	0.17	0.1556	-0.2873
25	6.2400	-0.06	0.15	0.1750	-0.2783
26	6.5000	-0.06	0.14	0.1924	-0.2682
27	6.7600	-0.06	0.12	0.2080	-0.2573
28	7.0200	-0.06	0.11	0.2216	-0.2456
29	7.2800	-0.06	0.09	0.2332	-0.2332
30	7.5400	-0.06	0.07	0.2429	-0.2203
31	7.8000	-0.06	0.06	0.2507	-0.2068
32	8.0600	-0.06	0.04	0.2566	-0.1930
33	8.3200	-0.06	0.02	0.2605	-0.1789
34	8.5800	-0.06	0.01	0.2625	-0.1647
35	8.8400	-0.06	-0.01	0.2625	-0.1504
36	9.1000	-0.06	-0.02	0.2606	-0.1361
37	9.3600	-0.06	-0.04	0.2568	-0.1220
38	9.6200	-0.06	-0.06	0.2511	-0.1082
39	9.8800	-0.06	-0.07	0.2434	-0.0947
40	10.1400	-0.06	-0.09	0.2337	-0.0817
41	10.4000	-0.06	-0.11	0.2222	-0.0693
42	10.6600	-0.06	-0.12	0.2087	-0.0575
43	10.9200	-0.06	-0.14	0.1932	-0.0466
44	11.1800	-0.06	-0.15	0.1758	-0.0365
45	11.4400	-0.06	-0.17	0.1565	-0.0275
46	11.7000	-0.06	-0.19	0.1353	-0.0195
47	11.9600	-0.06	-0.20	0.1121	-0.0128
48	12.2200	-0.06	-0.22	0.0870	-0.0073
49	12.4800	-0.06	-0.24	0.0599	-0.0033
50	12.7400	-0.06	-0.25	0.0309	-0.0009
51	13.0000	-0.06	-0.27	0.0000	0.0000

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Concrete Wall (Sliding and Bearing)
Date: 10/24/2018
By: RL with SJW edits

Wall Properties

Wall Height, H	=	13 ft	
Stem/Footing Unit Weight		145 pcf	
Stem Thickness	=	1.5 ft	
Footing Thickness	=	1.5 ft	Chudgar use 1.25 ft
Footing Width	=	2.83 ft	
Area of Footing (A)	=	4.25 ft^2/ft	
Sidewalk Width	=	16 ft	
Sidewalk Thickness	=	0.33 ft	
Footing Heel Width	=	0.67 ft	
Soil Unit Weight	=	120 pcf	

Active Pressure

Lateral Earth Pressure (EH)	=	60 pcf	At-Rest

Passive Pressure

Soil in Front of Footing	=	0 pcf	Neglect

Other Loading

Sidewalk Dead Load (DW)	=	50 psf	Assume 4" sidewalk, Chudgar use 75 psf
Pedestrian Live Load (PL)	=	75 psf	Chudgar use 250 psf

CHECK SLIDING

Resisting Force ↓

Weight of Stem (DC)	=	2501.25 lb/ft
Weight of Footing (DC)	=	615.53 lb/ft
Soil Weight Behind Wall (EV)	=	924.60 lb/ft
Sidewalk Dead Load (DW)	=	400 lb/ft
Pedestrian Live Load (PL)	=	600 lb/ft

Neglect PL when check sliding

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Sliding				Sliding				Sliding			
Factored Driving Force ←	=	7181.850 lb/ft	From RISA	Factored Driving Force ←	7773.696 lb/ft	From RISA		Factored Driving Force ←	6617 lb/ft	From RISA	
Factored Vertical Force ↓	=	3990 lb/ft		Factored Vertical Force ↓	3990 lb/ft			Factored Vertical Force ↓	3990 lb/ft		
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58		Coefficient of Friction	0.50	Chudgar use 0.58	
Capacity/Demand Ratio	=	0.28		Capacity/Demand Ratio	0.26			Capacity/Demand Ratio	0.30		

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Sliding				Sliding				Sliding			
Factored Driving Force ←	=	6791 lb/ft	From RISA	Factored Driving Force ←	7248 lb/ft	From RISA		Factored Driving Force ←	6617 lb/ft	From RISA	
Factored Vertical Force ↓	=	3990 lb/ft		Factored Vertical Force ↓	3990 lb/ft			Factored Vertical Force ↓	3990 lb/ft		
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58		Coefficient of Friction	0.50	Chudgar use 0.58	
Capacity/Demand Ratio	=	0.29		Capacity/Demand Ratio	0.28			Capacity/Demand Ratio	0.30		

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)				Load Combination 4 (Active + Normal Traffic)		
Sliding				Sliding				Sliding				Sliding		
Factored Driving Force ←	=	5031 lb/ft	From RISA	Factored Driving Force ←	5369 lb/ft	From RISA		Factored Driving Force ←	4902 lb/ft	From RISA		Factored Driving Force ←	4118 lb/ft	From RISA
Factored Vertical Force ↓	=	4441 lb/ft		Factored Vertical Force ↓	4441 lb/ft			Factored Vertical Force ↓	4441 lb/ft			Factored Vertical Force ↓	4441 lb/ft	
Coefficient of Friction	=	0.50	Chudgar use 0.58	Coefficient of Friction	0.50	Chudgar use 0.58		Coefficient of Friction	0.50	Chudgar use 0.58		Coefficient of Friction	0.50	Chudgar use 0.58
Capacity/Demand Ratio	=	0.44		Capacity/Demand Ratio	0.41			Capacity/Demand Ratio	0.45			Capacity/Demand Ratio	0.54	

SDOT
Seattle Department of Transportation

Project: 1st Avenue Areaway Assessment
Subject: Check External Stability for Concrete Wall (Sliding and Bearing)
Date: 10/24/2018
By: RL with SJW edits

CHECK BEARING PRESSURE

Allowable Bearing Pressure	=	2500	psf
Ultimate Bearing Pressure Factor	=	3	
Ultimate Bearing Pressue	=	7500	psf
Weight of Stem (DC)	=	2501.25	lb/ft
Weight of Footing (DC)	=	615.53	lb/ft
Sidewalk Dead Load (DW))	=	400	lb/ft
Soil Weight Behind Wall (EV)	=	924.60	lb/ft
Sidewalk Live Load (PL)	=	600	lb/ft
Footing Thickness	=	1.5	ft
Footing Width, L	=	2.83	ft
Moment of Intertia (I)	=	1.89	ft^4/ft
Perdendicular Dist to Neut Axis (c)	=	1.42	ft
Area of Footing (A)	=	2.83	ft^2/ft

AASHTO Load Combination (CASE 1)

Strength I: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.75LS + 1.75PL

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Bearing				Bearing				Bearing			
Overturning Moment	=	16300 lb-ft/ft	From "Wall Analysis"	Overturning Moment	19353 lb-ft/ft	From "Wall Analysis"		Overturning Moment	15636 lb-ft/ft	From "Wall Analysis"	
Factored Vertical Force ↓	=	5040 lb/ft		Factored Vertical Force ↓	5040 lb/ft			Factored Vertical Force ↓	5040 lb/ft		
Factored Bearing Pressure (P/A + M*c/I)	=	13992.27 psf/ft		Factored Bearing Pressure (P/A + M*c/I)	16279.06 psf/ft			Factored Bearing Pressure (P/A + M*c/I)	13494.55 psf/ft		
Ultimate Bearing Pressure	=	3750 psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750 psf	Chudgar factored in 0.55		Ultimate Bearing Pressure	3750 psf	Chudgar factored in 0.55	
Capacity/Demand Ratio	=	0.27	Chudgar has 0.07	Capacity/Demand Ratio	0.23			Capacity/Demand Ratio	0.28		

Strength II: 0.9DC + 0.65DW + 1.0EV + 1.35EH + 1.35LS + 1.35PL

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)			
Bearing				Bearing				Bearing			
Overturning Moment	=	15269 lb-ft/ft	From RISA	Overturning Moment	17641 lb-ft/ft	From "Wall Analysis"		Overturning Moment	15636 lb-ft/ft	From "Wall Analysis"	
Factored Vertical Force ↓	=	4800 lb/ft		Factored Vertical Force ↓	4800 lb/ft			Factored Vertical Force ↓	4800 lb/ft		
Factored Bearing Pressure (P/A + M*c/I)	=	13135.03 psf/ft		Factored Bearing Pressure (P/A + M*c/I)	14911.9 psf/ft			Factored Bearing Pressure (P/A + M*c/I)	13409.74 psf/ft		
Ultimate Bearing Pressure	=	3750 psf	Chudgar factored in 0.55	Ultimate Bearing Pressure	3750 psf	Chudgar factored in 0.55		Ultimate Bearing Pressure	3750 psf	Chudgar factored in 0.55	
Capacity/Demand Ratio	=	0.29	Chudgar has 0.08	Capacity/Demand Ratio	0.25			Capacity/Demand Ratio	0.28		

Service I: 1.0DC + 1.0DW + 1.0EV + 1.0EH + 1.0LS + 1.0PL

Load Combination 1 (Active + AASHTO Traffic)				Load Combination 3 (Active + Bus)				Load Combination 4 (Active + Truck Type 3)				Load Combination 4 (Active + Normal Traffic)		
Bearing				Bearing				Bearing				Bearing		
Overturning Moment	=	11323 lb-ft/ft	From "Wall Analysis"	Overturning Moment	13067.26 lb-ft/ft	From "Wall Analysis"		Overturning Moment	11582 lb-ft/ft	From "Wall Analysis"		Overturning Moment	9056 lb-ft/ft	From "Wal
Factored Vertical Force ↓	=	5041 lb/ft		Factored Vertical Force ↓	5041 lb/ft			Factored Vertical Force ↓	5041 lb/ft			Factored Vertical Force ↓	5041 lb/ft	
Factored Bearing Pressure (P/A + M*c/I)	=	10264.22 psf/ft		Factored Bearing Pressure (P/A + M*c/I)	11570.96 psf/ft			Factored Bearing Pressure (P/A + M*c/I)	10458.25 psf/ft			Factored Bearing Pressure (P/A + M*c/I)	8565.588 psf/ft	
Allowable Bearing Pressure	=	3750 psf	Chudgar use Ultimate	Allowable Bearing Pressure	3750 psf	Chudgar use Ultimate		Allowable Bearing Pressure	3750 psf	Chudgar use Ultimate		Allowable Bearing Pressure	3750 psf	Chudgar us
Capacity/Demand Ratio	=	0.37	Chudgar has 0.22	Capacity/Demand Ratio	0.32			Capacity/Demand Ratio	0.36			Capacity/Demand Ratio	0.44	

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Project: 1st Ave. Areaways Review	**Designed By:**	**Date:** 10/30/18	
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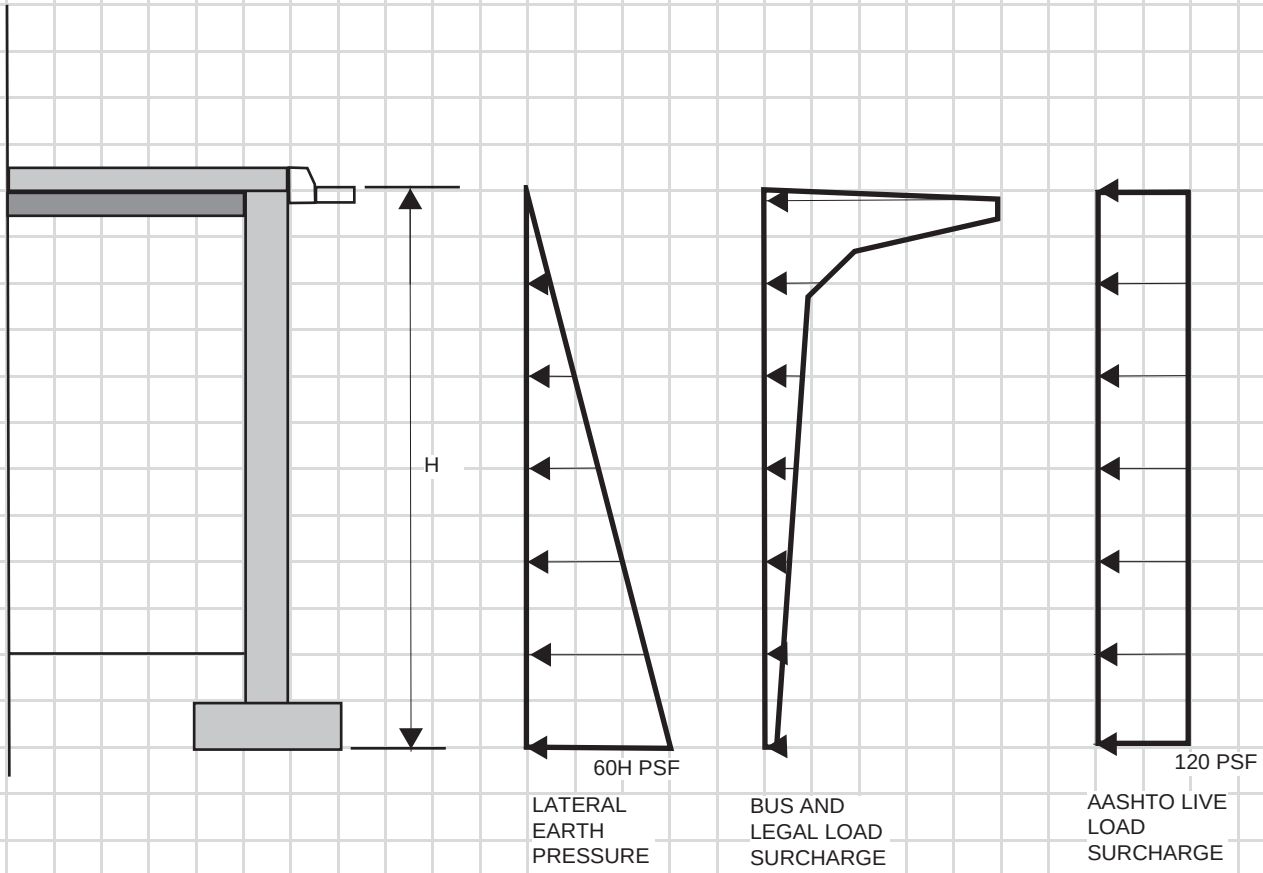


LATERAL EARTH PRESSURE DIAGRAM

TYPICAL FOR ALL WALLS
ko = 0.5
soil unit weight γ = 120 pcf

1/4" Grid

3.10.10—Requirements for Temporary Bridges and Stage Construction

Any bridge or partially constructed bridge that is expected to be temporary for more than 5 years shall be designed using the requirements for permanent structures and shall not use the provisions of this Article.

The requirement that an earthquake shall not cause collapse of all or part of a bridge, as stated in Article 3.10.1, shall apply to temporary bridges expected to carry traffic. It shall also apply to those bridges that are constructed in stages and expected to carry traffic and/or pass over routes that carry traffic. The elastic seismic response coefficient and the ground acceleration coefficient given in Article 3.10.4.2 may be reduced by a factor of not more than 2 in order to calculate the component elastic forces and displacements. Response and acceleration coefficients for construction sites that are close to active faults shall be the subject of special study. The response modification factors given in Article 3.10.7 may be increased by a factor of not more than 1.5 in order to calculate the design forces. This factor shall not be applied to connections as defined in Table 3.10.7.1-2.

The minimum support length provisions of Article 4.7.4.4 shall apply to all temporary bridges and staged construction.

C3.10.10

The option to use a reduced response coefficient and a reduced ground acceleration coefficient reflects the limited exposure period for a temporary bridge.

3.11—EARTH PRESSURE: *EH*, *ES*, *LS*, AND *DD*

3.11.1—General

Earth pressure shall be considered as a function of the:

- type and unit weight of earth,
- water content,
- soil creep characteristics,
- degree of compaction,
- location of groundwater table,
- earth-structure interaction,
- amount of surcharge,
- earthquake effects,
- back slope angle, and
- wall inclination.

C3.11.1

Walls that can tolerate little or no movement should be designed for at-rest earth pressure. Walls which can move away from the soil mass should be designed for pressures between active and at-rest conditions, depending on the magnitude of the tolerable movements. Movement required to reach the minimum active pressure or the maximum passive pressure is a function of the wall height and the soil type. Some typical values of these mobilizing movements, relative to wall height, are given in Table C3.11.1-1, where:

Δ = movement of top of wall required to reach minimum active or maximum passive pressure by tilting or lateral translation (ft)
H = height of wall (ft)

Table C3.11.1-1—Approximate Values of Relative Movements Required to Reach Active or Passive Earth Pressure Conditions (Clough and Duncan, 1991)

Type of Backfill	Values of Δ/H	
	Active	Passive
Dense sand	0.001	0.01
Medium dense sand	0.002	0.02
Loose sand	0.004	0.04
Compacted silt	0.002	0.02
Compacted lean clay	0.010	0.05
Compacted fat clay	0.010	0.05

Silt and lean clay shall not be used for backfill unless suitable design procedures are followed and construction control measures are incorporated in the construction documents to account for their presence. Consideration shall be given for the development of pore water pressure within the soil mass in accordance with Article 3.11.3. Appropriate drainage provisions shall be provided to prevent hydrostatic and seepage forces from developing behind the wall in accordance with the provisions in Section 11. In no case shall highly plastic clay be used for backfill.

The evaluation of the stress induced by cohesive soils is highly uncertain due to their sensitivity to shrink-swell, wet-dry and degree of saturation. Tension cracks can form, which considerably alter the assumptions for the estimation of stress. Extreme caution is advised in the determination of lateral earth pressures assuming the most unfavorable conditions. If possible, cohesive or other fine-grained soils should be avoided as backfill.

For walls retaining cohesive materials, the effects of soil creep should be taken into consideration in estimating the design earth pressures. Evaluation of soil creep is complex and requires duplication in the laboratory of the stress conditions in the field as discussed by Mitchell (1976).

Under stress conditions close to the minimum active or maximum passive earth pressures, cohesive soils indicated in Table C3.11.1-1 creep continually, and the movements shown produce active or passive pressures only temporarily. If there is no further movement, active pressures will increase with time, approaching the at-rest pressure, and passive pressures will decrease with time, approaching values on the order of 40 percent of the maximum short-term value. A conservative assumption to account for unknowns would be to use the at-rest pressure based on the residual strength of the soil.

3.11.2—Compaction

Where activity by mechanical compaction equipment is anticipated within a distance of one-half the height of the wall, taken as the difference in elevation between the point where finished grade intersects the back of the wall and the base of the wall, the effect of additional earth pressure that may be induced by compaction shall be taken into account.

C3.11.2

Compaction-induced earth pressures may be estimated using the procedures described by Clough and Duncan (1991). The heavier the equipment used to compact the backfill, and the closer it operates to the wall, the larger are the compaction-induced pressures. The magnitude of the earth pressures exerted on a wall by compacted backfill can be minimized by using only small rollers or hand compactors within a distance of one-half wall height from the back of the wall. For MSE structures, compaction stresses are already included in the design model and specified compaction procedures.

3.11.3—Presence of Water

If the retained earth is not allowed to drain, the effect of hydrostatic water pressure shall be added to that of earth pressure.

In cases where water is expected to pond behind a wall, the wall shall be designed to withstand the hydrostatic water pressure plus the earth pressure.

Submerged unit weights of the soil shall be used to determine the lateral earth pressure below the groundwater table.

C3.11.3

The effect of additional pressure caused by groundwater is shown in Figure C3.11.3-1.

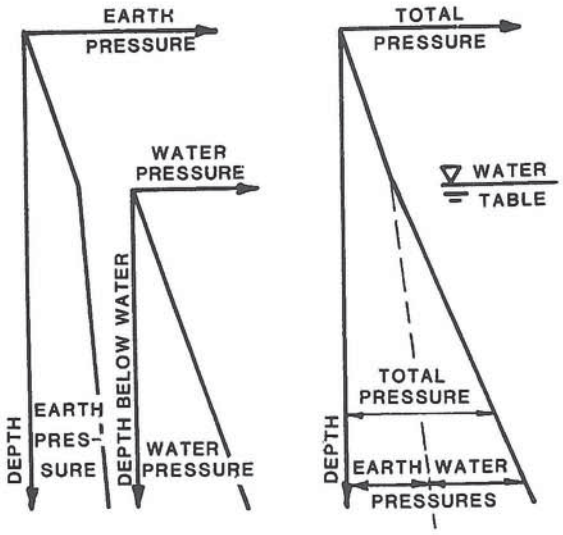


Figure C3.11.3-1—Effect of Groundwater Table

The development of hydrostatic water pressure on walls should be eliminated through use of crushed rock, pipe drains, gravel drains, perforated drains or geosynthetic drains.

Pore water pressures behind the wall may be approximated by flow net procedures or various analytical methods.

If the groundwater levels differ on opposite sides of the wall, the effects of seepage on wall stability and the potential for piping shall be considered. Pore water pressures shall be added to the effective horizontal stresses in determining total lateral earth pressures on the wall.

3.11.4—Effect of Earthquake

The effects of wall inertia and probable amplification of active earth pressure and/or mobilization of passive earth masses by earthquake shall be considered.

C3.11.4

The Mononobe-Okabe method for determining equivalent static fluid pressures for seismic loads on gravity and semigravity retaining walls is presented in Appendix A11.

The Mononobe-Okabe analysis is based, in part, on the assumption that the backfill soils are unsaturated and thus, not susceptible to liquefaction.

Where soils are subject to both saturation and seismic or other cyclic/instantaneous loads, special consideration should be given to address the possibility of soil liquefaction.

3.11.5—Earth Pressure: *EH*

3.11.5.1—Lateral Earth Pressure

C3.11.5.1

Lateral earth pressure shall be assumed to be linearly proportional to the depth of earth and taken as:

$$p = k\gamma_s z \qquad (3.11.5.1\text{-}1)$$

where:

p = lateral earth pressure (ksf)
k = coefficient of lateral earth pressure taken as k_o, specified in Article 3.11.5.2, for walls that do not

deflect or move, k_a, specified in Articles 3.11.5.3, 3.11.5.6 and 3.11.5.7, for walls that deflect or move sufficiently to reach minimum active conditions, or k_p, specified in Article 3.11.5.4, for walls that deflect or move sufficiently to reach a passive condition

γ_s = unit weight of soil (kcf)

z = depth below the surface of earth (ft)

The resultant lateral earth load due to the weight of the backfill shall be assumed to act at a height of $H/3$ above the base of the wall, where H is the total wall height, measured from the surface of the ground at the back of the wall to the bottom of the footing or the top of the leveling pad (for MSE walls).

Although previous versions of these Specifications have required design of conventional gravity walls for a resultant earth pressure located $0.4H$ above the wall base, the current specifications require design for a resultant located $H/3$ above the base. This requirement is consisten with historical practice and with calibrated resistance factors in Section 11. The resultant lateral load due to the earth pressure may act as high as $0.4H$ above the base of the wall for a mass concrete gravity retaining wall, where H is the total wall height measured from the top of the backfill to the base of the footing, where the wall deflects laterally, i.e., translates, in response to lateral earth loading. For such structures, the backfill behind the wall must slide down along the back of the wall for the retained soil mass to achieve the active state of stress. Experimental results indicate that the backfill arches against the upper portion of the wall as the wall translates, causing an upward shift in the location at which the resultant of the lateral earth load is transferred to the wall (Terzaghi, 1934; Clausen and Johansen et al., 1972; Sherif et al., 1982). Such walls are not representative of typical gravity walls used in highway applications.

For most gravity walls which are representative of those used in highway construction, nongravity cantilever retaining walls or other flexible walls which tilt or deform laterally in response to lateral loading, e.g., MSE walls, as well as walls which cannot translate or tilt, e.g., integral abutment walls, significant arching of the backfill against the wall does not occur, and the resultant lateral load due to earth pressure acts at a height of $H/3$ above the base of the wall. Furthermore, where wall friction is not considered in the analysis, it is sufficiently conservative to use a resultant location of $H/3$, even if the wall can translate.

3.11.5.2—At-Rest Lateral Earth Pressure Coefficient, k_o

For normally consolidated soils, vertical wall, and level ground, the coefficient of at-rest lateral earth pressure may be taken as:

$$k_o = 1 - \sin \phi'_f \qquad (3.11.5.2\text{-}1)$$

0.5 per 2015 Geotechnical Report

where:

ϕ'_f = effective friction angle of soil

k_o = coefficient of at-rest lateral earth pressure

C3.11.5.2

For typical cantilevered walls over 5.0 ft high with structural grade backfill, calculations indicate that the horizontal movement of the top of the wall due to a combination of structural deformation of the stem and rotation of the foundation is sufficient to develop active conditions.

In many instances, the OCR may not be known with enough accuracy to calculate k_o using Eq. 3.11.5.2-2. Based on information on this issue provided by Holtz and Kovacs (1981), in general, for lightly overconsolidated

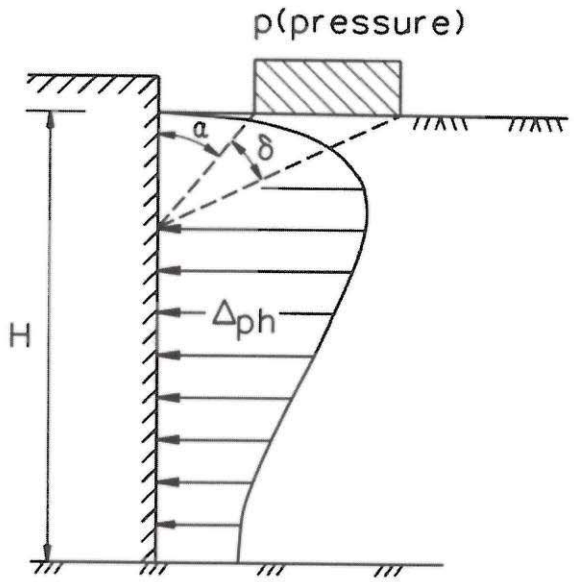


Figure 3.11.6.2-1—Horizontal Pressure on Wall Caused by a Uniformly Loaded Strip

The horizontal pressure, Δ_{ph} in ksf, on a wall resulting from a point load may be taken as:

Use this approach for live load surcharge of bus and legal load (LS)

$$\Delta_{ph} = \frac{P}{\pi R^2}\left[\frac{3ZX^2}{R^3} - \frac{R(1-2\nu)}{R+Z}\right] \qquad (3.11.6.2\text{-}2)$$

where:

P = point load (kip)
R = radial distance from point of load application to a point on the wall as specified in Figure 3.11.6.2-2 where $R = (x^2 + y^2 + z^2)^{0.5}$ (ft)
X = horizontal distance from back of wall to point of load application (ft)
Y = horizontal distance from point on the wall under consideration to a plane, which is perpendicular to the wall and passes through the point of load application measured along the wall (ft)
Z = vertical distance from point of load application to the elevation of a point on the wall under consideration (ft)
ν = Poisson's ratio (dim.)

The point on the wall does not have to lie in a plane which is perpendicular to the wall and passes through the point of load application.

Poisson's ratio for soils varies from about 0.25 to 0.49, with lower values more typical for granular and stiff cohesive soils and higher values more typical for soft cohesive soils.

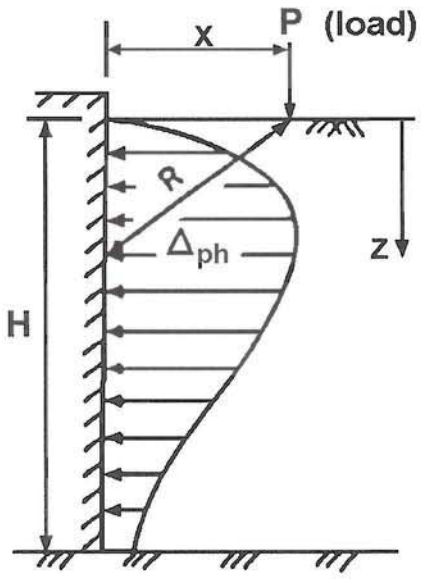


Figure 3.11.6.2-2—Horizontal Pressure on a Wall Caused by a Point Load

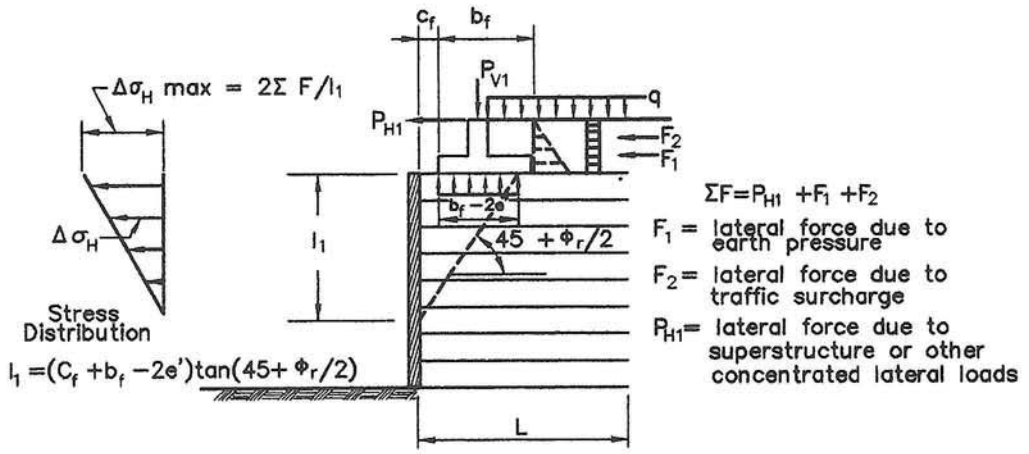
The horizontal pressure, Δ_{ph} in ksf, resulting from an infinitely long line load parallel to a wall may be taken as:

$$\Delta_{ph} = \frac{4Q}{\pi} \frac{X^2 Z}{R^4} \qquad (3.11.6.2\text{-}3)$$

where:

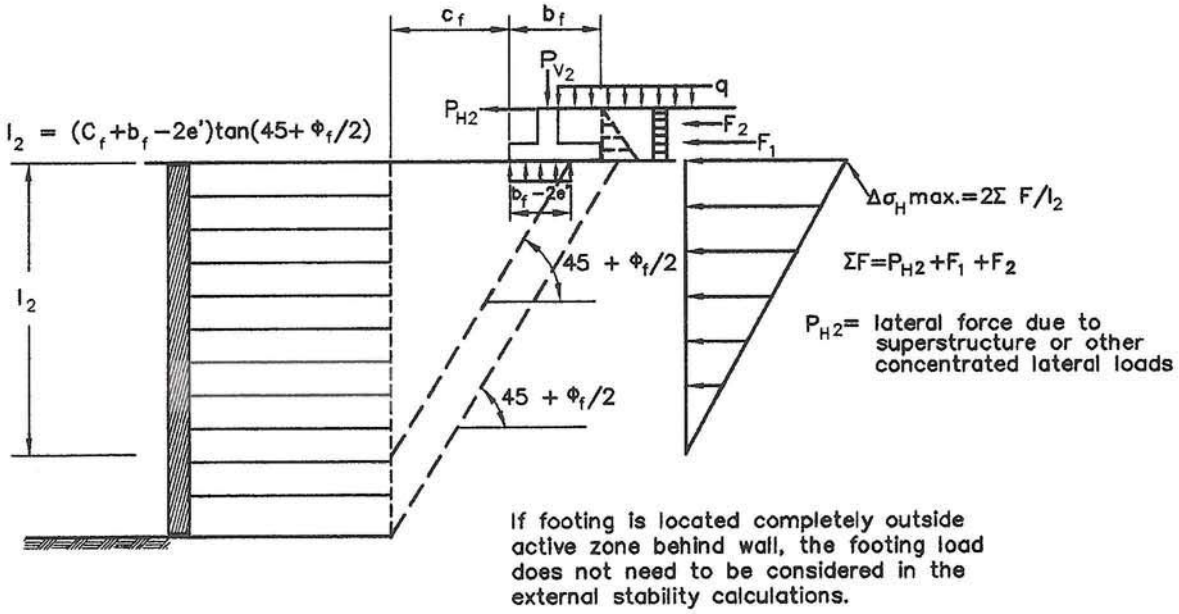
Q = load intensity in kip/ft

and all other notation is as defined above and shown in Figure 3.11.6.2-3.



e' = eccentricity of load on footing (see Figure 11.10.10.1-1 for example of how to calculate this)

a—Distribution of Stress for Internal Stability Calculations



b—Distribution of Stress for External Stability Calculations

Figure 3.11.6.3-2—Distribution of Stress from Concentrated Horizontal Loads

3.11.6.4—Live Load Surcharge (*LS*)

A live load surcharge shall be applied where vehicular load is expected to act on the surface of the backfill within a distance equal to one-half the wall height behind the back face of the wall. If the surcharge is for a highway, the intensity of the load shall be consistent with the provisions of Article 3.6.1.2. If the surcharge is for other than a highway, the Owner shall specify and/or approve appropriate surcharge loads.

The increase in horizontal pressure due to live load surcharge may be estimated as:

C3.11.6.4

The tabulated values for h_{eq} were determined by evaluating the horizontal force against an abutment or wall from the pressure distribution produced by the vehicular live load of Article 3.6.1.2. The pressure distributions were developed from elastic half-space solutions using the following assumptions:

- Vehicle loads are distributed through a two-layer system consisting of pavement and soil subgrade

$$\Delta_p = k\gamma_s h_{eq} \quad (3.11.6.4\text{-}1)$$

where:

Δ_p = constant horizontal earth pressure due to live load surcharge (ksf)
γ_s = total unit weight of soil (kcf)
k = coefficient of lateral earth pressure
h_{eq} = equivalent height of soil for vehicular load (ft)

Equivalent heights of soil, h_{eq}, for highway loadings on abutments and retaining walls may be taken from Tables 3.11.6.4-1 and 3.11.6.4-2. Linear interpolation shall be used for intermediate wall heights.

The wall height shall be taken as the distance between the surface of the backfill and the bottom of the footing along the pressure surface being considered.

Table 3.11.6.4-1—Equivalent Height of Soil for Vehicular Loading on Abutments Perpendicular to Traffic

Abutment Height (ft)	h_{eq} (ft)
5.0	4.0
10.0	3.0
≥20.0	2.0

Table 3.11.6.4-2—Equivalent Height of Soil for Vehicular Loading on Retaining Walls Parallel to Traffic

Retaining Wall Height (ft)	h_{eq} (ft) Distance from wall backface to edge of traffic	
	0.0 ft	1.0 ft or Further
5.0	5.0	2.0
10.0	3.5	2.0
≥20.0	2.0	2.0

The load factor for both vertical and horizontal components of live load surcharge shall be taken as specified in Table 3.4.1-1 for live load surcharge.

3.11.6.5—Reduction of Surcharge

If the vehicular loading is transmitted through a structural slab, which is also supported by means other than earth, a corresponding reduction in the surcharge loads may be permitted.

- Poisson's ratio for the pavement and subgrade materials are 0.2 and 0.4, respectively
- Wheel loads were modeled as a finite number of point loads distributed across the tire area to produce an equivalent tire contact stress
- The process for equating wall moments resulting from the elastic solution with the equivalent surcharge method used a wall height increment of 0.25 ft.

The value of the coefficient of lateral earth pressure k is taken as k_o, specified in Article 3.11.5.2, for walls that do not deflect or move, or k_a, specified in Articles 3.11.5.3, 3.11.5.6 and 3.11.5.7, for walls that deflect or move sufficiently to reach minimum active conditions.

The analyses used to develop Tables 3.11.6.4-1 and 3.11.6.4-2 are presented in Kim and Barker (1998).

The values for h_{eq} given in Tables 3.11.6.4-1 and 3.11.6.4-2 are generally greater than the traditional 2.0 ft of earth load historically used in the AASHTO specifications, but less than those prescribed in previous editions (i.e., before 1998) of this specification. The traditional value corresponds to a 20.0-kip single unit truck formerly known as an H10 truck, Peck et al. (1974). This partially explains the increase in h_{eq} in previous editions of this specification. Subsequent analyses, i.e., Kim and Barker (1998) show the importance of the direction of traffic, i.e., parallel for a wall and perpendicular for an abutment on the magnitude of h_{eq}. The magnitude of h_{eq} is greater for an abutment than for a wall due to the proximity and closer spacing of wheel loads to the back of an abutment compared to a wall.

The backface of the wall should be taken as the pressure surface being considered. Refer to Article C11.5.5 for application of surcharge pressures on retaining walls.

C3.11.6.5

This Article relates primarily to approach slabs which are supported at one edge by the backwall of an abutment, thus transmitting load directly thereto.

recommend founding it on improved soils or deep foundations that extend through the fill layer into dense, glacially overridden soil.

5.4 LATERAL EARTH PRESSURES ON AREAWAYS

Streetcar loads will induce lateral earth pressures acting on the buried portions of areaways and basement walls. We recommend evaluating buried walls for lateral earth pressures wherever streetcar loads are anticipated within one half of the wall height. Figure 5-1 presents lateral earth pressure distributions for footings, equipment, or other surcharge loading. We recommend assuming a static, at-rest lateral earth pressure coefficient, K_o, of 0.5 for use in estimating surcharge pressures on areaway walls.

We recommend that the geotechnical and structural engineers of record perform a visual survey of areaway wall conditions in those areas where track slab surcharges are anticipated within one half of the areaway wall height. This task should be performed during the 60% design phase.

5.5 BASE FOOTING FRICTION

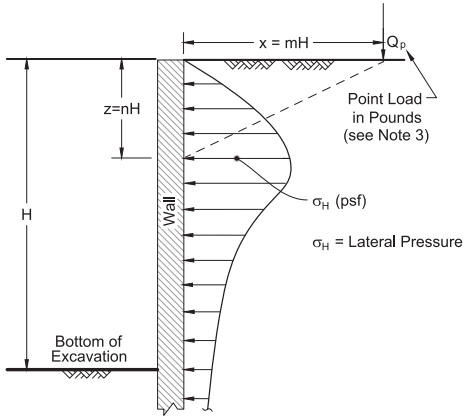
Lateral forces would be resisted by soil friction against the bottom of the footing or slab. We recommend that a coefficient of friction of 0.35 be used between cast-in-place concrete and compacted structural fill. This value includes a factor of safety of 1.5.

5.6 POLE FOUNDATIONS

Several poles are proposed along the alignment; however, specific pole locations have not been determined at the time of this report. We understand the pole foundations will be designed using City standard plans for strain pole foundations. For design purposes, we recommend assuming a lateral bearing pressure of 150 psf per foot (psf/ft) for portions of the alignment north of Cherry St and 100 psf/ft for portions of the alignment south of Cherry St.

5.7 ADDITIONAL SUBSURFACE EXPLORATIONS

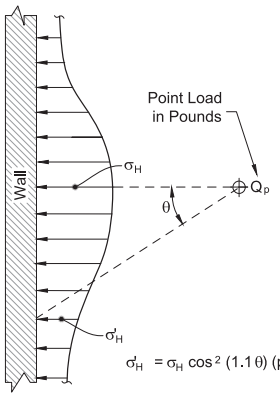
After reviewing the existing subsurface information, we do not recommend additional subsurface explorations for the proposed streetcar track design unless some site-specific soil-structure interaction issues become known during the 60% and 90% design phases. Some additional explorations may be warranted for pole foundations or construction near sensitive structures after those locations have been determined.



ELEVATION VIEW

For $m \le 0.4$: $\sigma_H = 0.28 \frac{Q_p}{H^2} \frac{n^2}{(0.16 + n^2)^3}$ (psf) (see Note 3)

For $m > 0.4$: $\sigma_H = 1.77 \frac{Q_p}{H^2} \frac{m^2 n^2}{(m^2 + n^2)^3}$ (psf)

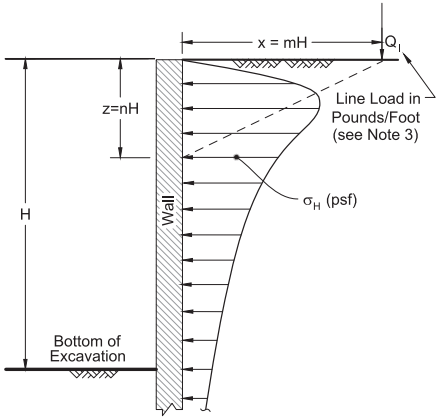


$\sigma'_H = \sigma_H \cos^2(1.1\theta)$ (psf)

PLAN VIEW

A) LATERAL PRESSURE DUE TO POINT LOAD
i.e. SMALL ISOLATED FOOTING OR WHEEL LOAD

(NAVFAC DM 7.2, 1986)



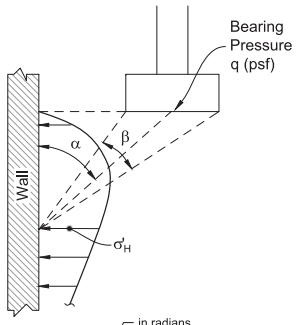
ELEVATION VIEW

For $m \le 0.4$: $\sigma_H = 0.20 \frac{Q_l}{H} \frac{n}{(0.16 + n^2)^2}$ (psf) (see Note 3)

For $m > 0.4$: $\sigma_H = 1.28 \frac{Q_l}{H} \frac{m^2 n}{(m^2 + n^2)^2}$ (psf)

B) LATERAL PRESSURE DUE TO LINE LOAD
i.e. NARROW CONTINUOUS FOOTING
PARALLEL TO WALL

(NAVFAC DM 7.2, 1986)

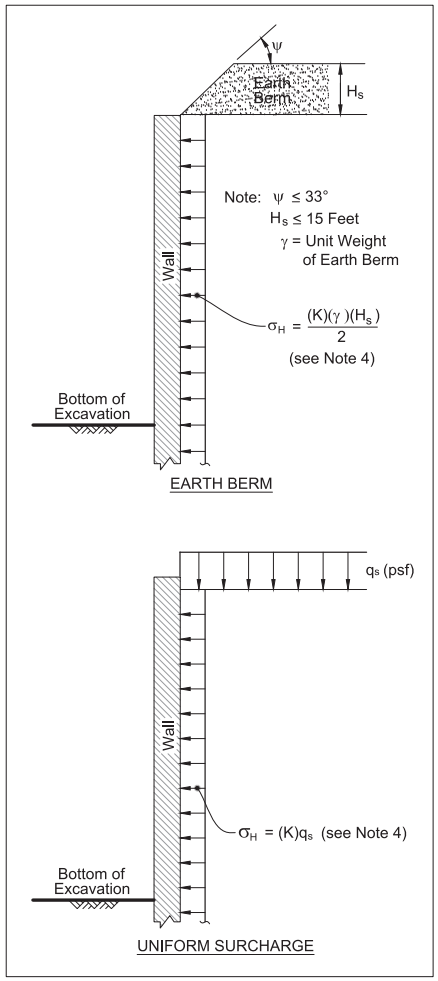


$\sigma_H = \frac{2q}{\pi}(\beta - \sin\beta \cos 2\alpha)$ (psf)

in radians

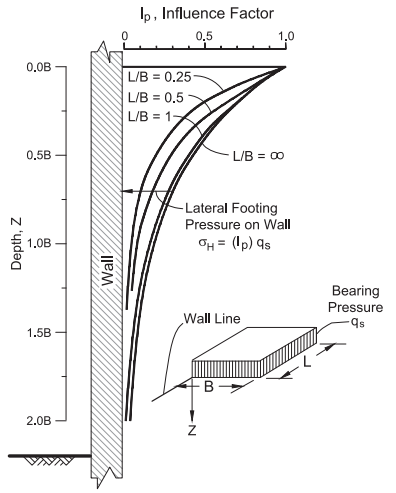
C) LATERAL PRESSURE DUE TO STRIP LOAD

(derived from Fang, *Foundation Engineering Handbook*, 1991)



D) LATERAL PRESSURE DUE TO EARTH BERM
OR UNIFORM SURCHARGE

(derived from Poulos and Davis, *Elastic Solutions for Soil and Rock Mechanics*, 1974; and Terzaghi and Peck, *Soil Mechanics in Engineering Practice*, 1967)



E) LATERAL PRESSURE DUE
TO ADJACENT FOOTING

(derived from NAVFAC DM 7.2, 1986; and Sandhu, *Earth Pressure on Walls Due to Surcharge*, 1974)

NOTES

1. Figures are not drawn to scale.
2. Applicable surcharge pressures should be added to appropriate permanent wall lateral earth and water pressure.
3. If point or line loads are close to the back of the wall such that $m \le 0.4$, it may be more appropriate to model the actual load distribution (i.e., Detail E) or use more rigorous analysis methods.
4. Use a K_o value of K_o=0.5.
5. For areas where fill will be placed immediately behind and above the top elevation of the wall, Diagram D can be used to determine loads on the wall. For narrow fills adjacent to the wall, Diagram C can be used.

Center City Connector Streetcar
Seattle, Washington

RECOMMENDED SURCHARGE LOADING FOR TEMPORARY AND PERMANENT WALLS

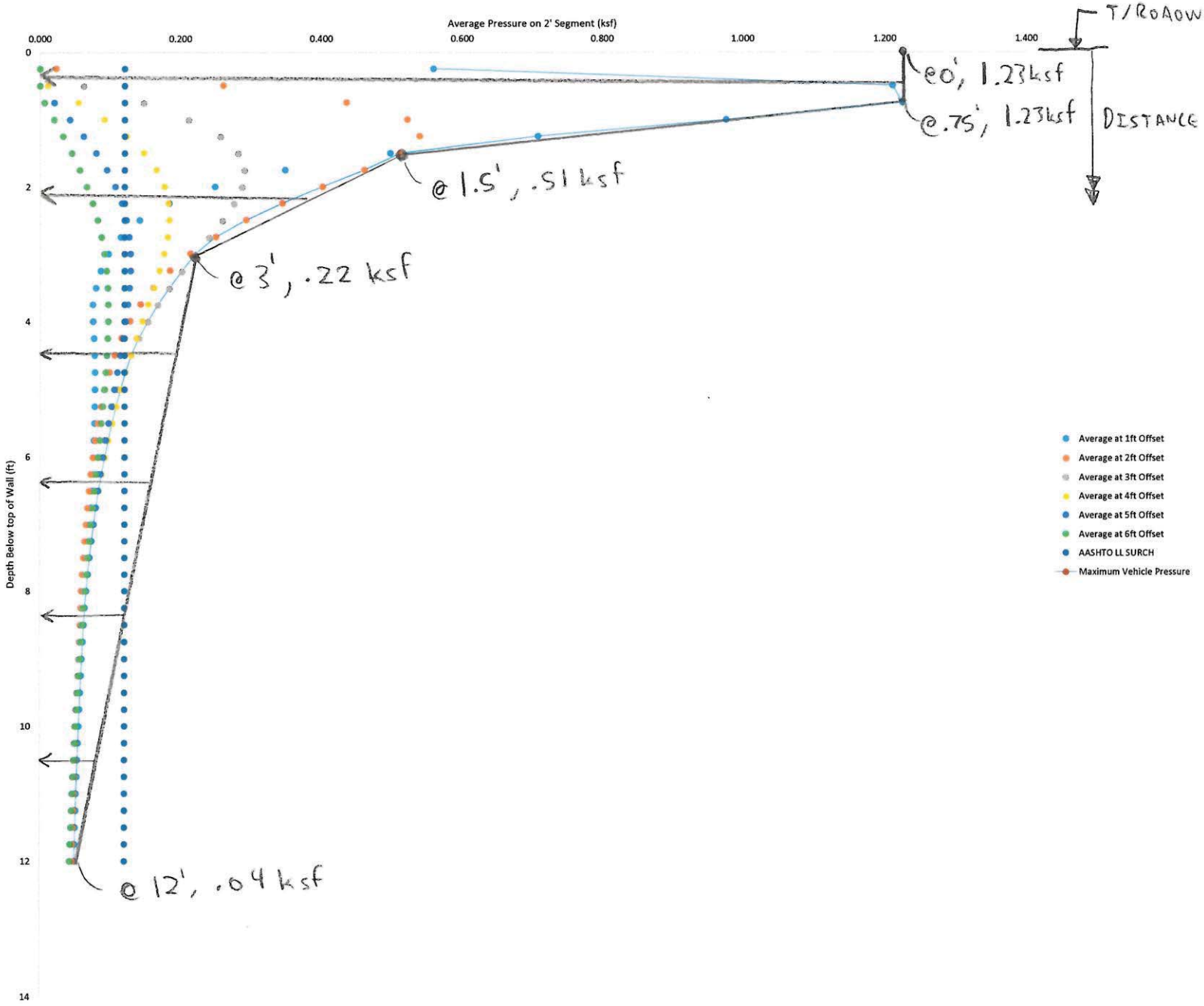
February 2015 21-1-22041-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 5-1

DEGOLF BUS WALL LATERAL LOADING

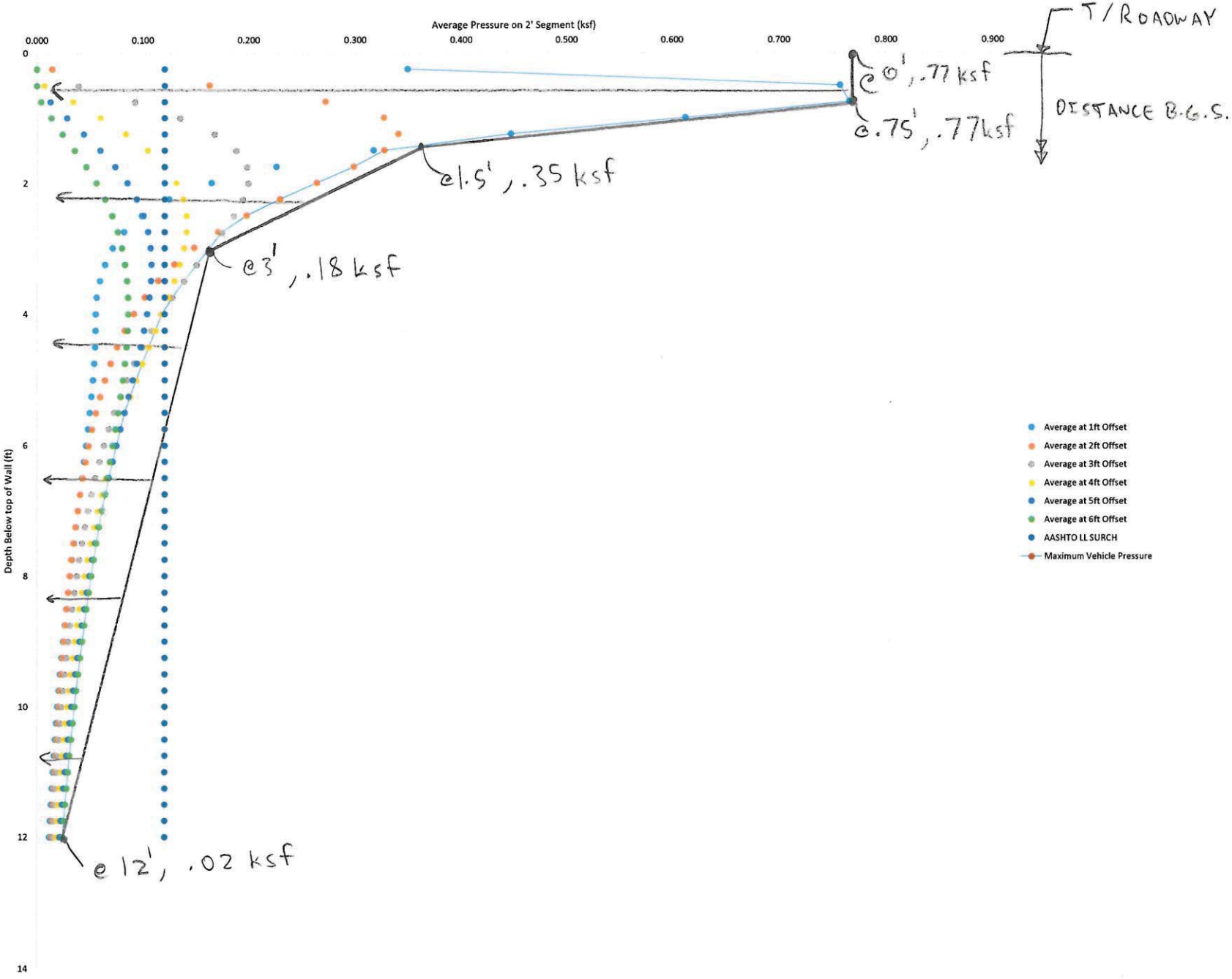
by RAB 10/22/18



FROM SUMMARIZED DATA OF "12' WALL SURCHARGE - DEGOLF BUS.xlsx"

by RAB 10/22/18

TYPE 3 TRUCK REAR TANDEM LOADING



From SUMMARIZED DATA of "12' Wall Surcharge Type 3 Truck.xlsx"

Calculations

Both have an adjustable offset from closest wheel line to curb; see highlighted results

1. 12’ Surcharge Earth Pressures_DE60LF Bus.xlsx
2. 12' Surcharge Earth Pressures_Type 3 Truck.xlsx

References

1. AASHTO LRFD 8th Edition
2. DE60LF Bus Dimensions and Load Summary
3. WSDOT BDM Legal Vehicles Excerpt

Major Assumptions

- Lateral pressure due to large vehicle loads is per AASHTO 3.11.6 for point loads using a poisons ratio of .33

Key Findings

- Wall sections further than ~6’ along the wall width away from a wheel load experience negligible loading (i.e. less than 20% of AASHTO traffic surcharge pressures)
- Wall pressures are highest at the top 3’ of wall for a wheel placed 1’ off of the curb (in excess of 2 ksf)
- Wall pressures are highest near the middle height of wall for a wheel line approximately 6’ to 10’ off of the curb (up to 0.1 ksf)
- For a wheel offset of ½*H.wall=~6 ft, the middle of wall height still experiences large lateral pressure

Summaries are provided on pages 2 through 5 for:

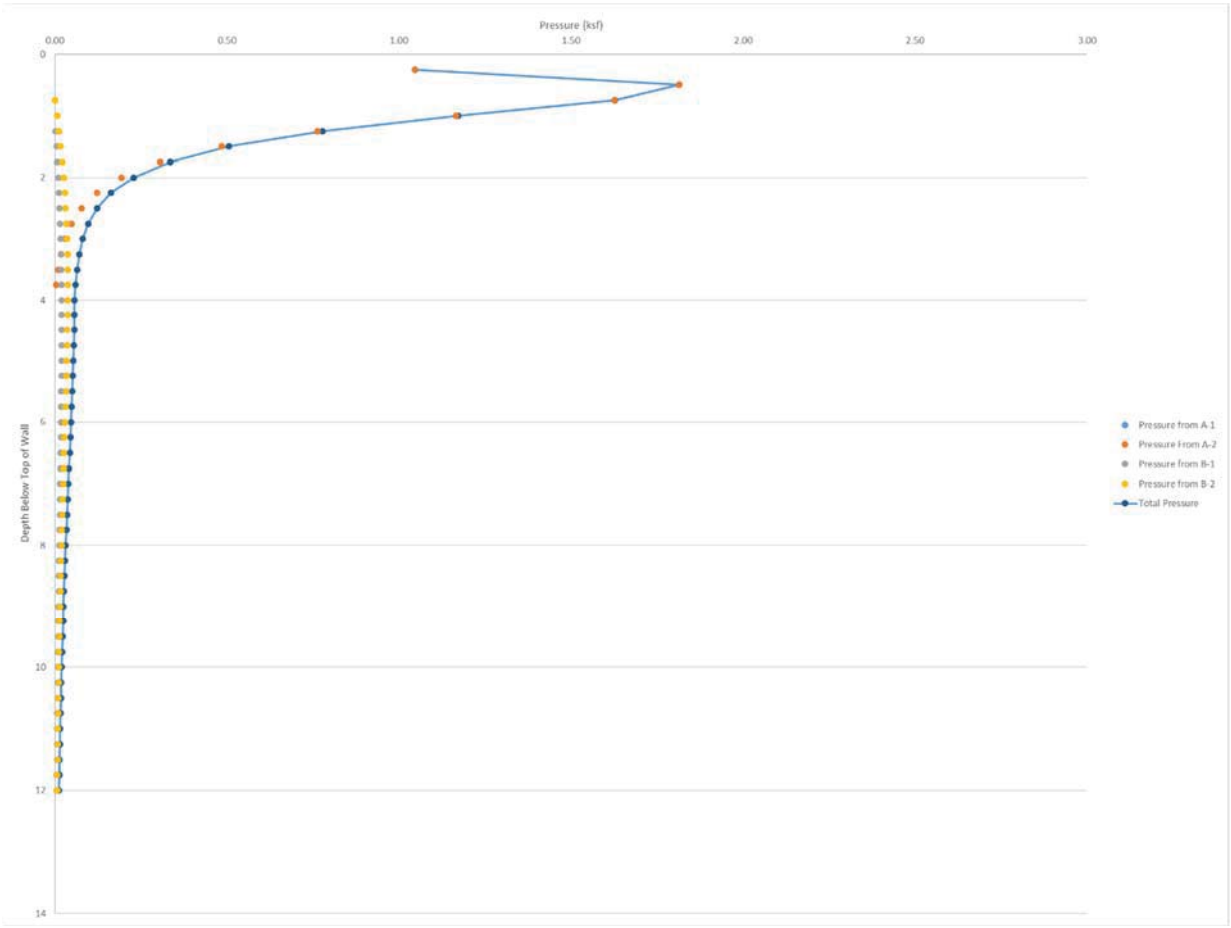
- Wheel line 1’ from wall-Type 3 Truck Rear Tandem and DE60LF Bus
- Wheel line 10’ from wall-Type 3 Truck Rear Tandem and DE60LF Bus

Results-Wheel Line 1' from Wall:

Truck Type 3 Rear Tandem:

Position along Wall Relative to Rear Wheel (2' spa. Typical), ft.	LOADING FROM TYPE 3						
	Lateral pressure (ksf) at depth below grade (ft)						
	0.25	2	4	6	8	10	12
8	0.000	0.009	0.022	0.022	0.017	0.012	0.008
6	0.000	0.027	0.040	0.036	0.025	0.016	0.010
4	1.047	0.228	0.056	0.047	0.031	0.020	0.012
2	0.000	0.050	0.062	0.051	0.034	0.021	0.012
0	1.047	0.228	0.056	0.047	0.031	0.020	0.012
-2	0.000	0.027	0.040	0.036	0.025	0.016	0.010
-4	0.000	0.009	0.022	0.022	0.017	0.012	0.008

Summary of Pressures at Depths and Locations Along Wall



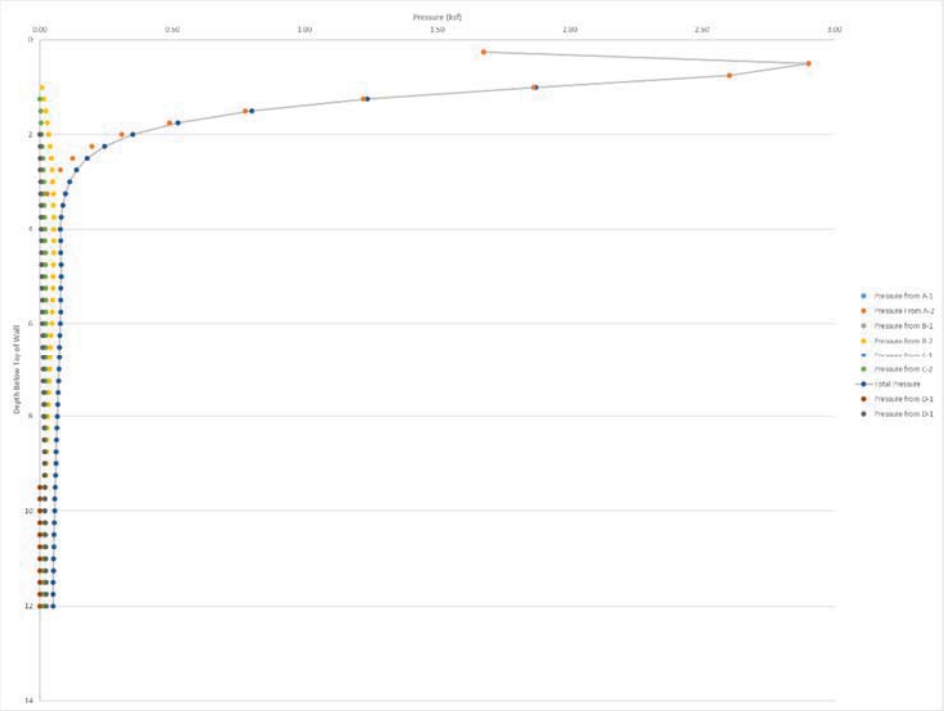
Maximum Pressure Diagram (Typical at a Wheel)

Results-Wheel Line 1' from Wall:

DE60LF Bus:

Position along Wall Relative to Rear Wheel (2' spa. Typical), ft.	LOADING FROM BUS Lateral pressure (ksf) at depth below grade (ft)						
	0.25	2	4	6	8	10	12
33	0.000	0.000	0.009	0.014	0.015	0.013	0.011
31	0.000	0.004	0.018	0.023	0.022	0.018	0.015
29	0.000	0.012	0.031	0.034	0.030	0.024	0.018
27	0.000	0.040	0.044	0.044	0.036	0.028	0.021
25	0.938	0.219	0.049	0.047	0.038	0.029	0.022
23	0.000	0.020	0.042	0.042	0.035	0.028	0.021
21	0.000	0.010	0.028	0.031	0.029	0.024	0.019
19	0.000	0.003	0.016	0.021	0.021	0.020	0.017
17	0.000	0.000	0.007	0.013	0.016	0.016	0.016
15	0.000	0.000	0.003	0.008	0.012	0.014	0.015
13	0.000	0.000	0.001	0.007	0.012	0.015	0.016
11	0.000	0.000	0.003	0.010	0.015	0.018	0.020
9	0.000	0.000	0.008	0.017	0.022	0.024	0.025
7	0.000	0.001	0.019	0.028	0.031	0.032	0.032
5	0.000	0.010	0.036	0.044	0.044	0.041	0.039
3	0.000	0.025	0.058	0.062	0.057	0.050	0.045
0	1.675	0.350	0.078	0.077	0.066	0.056	0.050
-2	0.000	0.042	0.068	0.070	0.062	0.053	0.047
-4	0.000	0.017	0.047	0.053	0.050	0.045	0.042
-6	0.000	0.005	0.027	0.036	0.037	0.036	0.034
-8	0.000	0.000	0.013	0.022	0.025	0.026	0.026

Summary of Pressures at Depths and Locations Along Wall



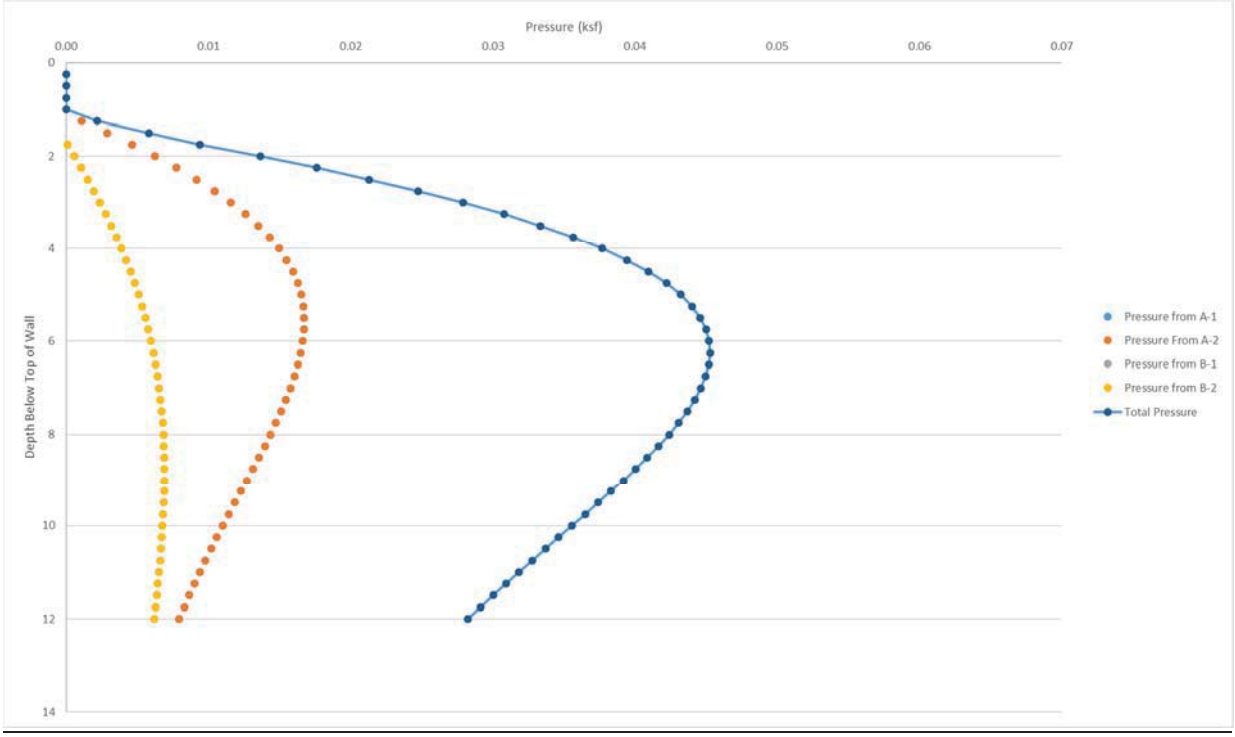
Maximum Pressure Diagram (Typical at Rear Wheel)

Results-Wheel Line 10' from Wall:

Truck Type 3 Rear Tandem:

Position along Wall Relative to Rear Wheel (2' spa. Typical), ft.	LOADING FROM TYPE 3 Lateral pressure (ksf) at depth below grade (ft)						
	0.25	2	4	6	8	10	12
8	0.000	0.004	0.020	0.027	0.028	0.025	0.021
6	0.000	0.008	0.028	0.036	0.035	0.030	0.025
4	0.000	0.012	0.035	0.043	0.040	0.034	0.027
2	0.000	0.014	0.038	0.045	0.042	0.036	0.028
0	0.000	0.012	0.035	0.043	0.040	0.034	0.027
-2	0.000	0.008	0.028	0.036	0.035	0.030	0.025
-4	0.000	0.004	0.020	0.027	0.028	0.025	0.021

Summary of Pressures at Depths and Locations Along Wall



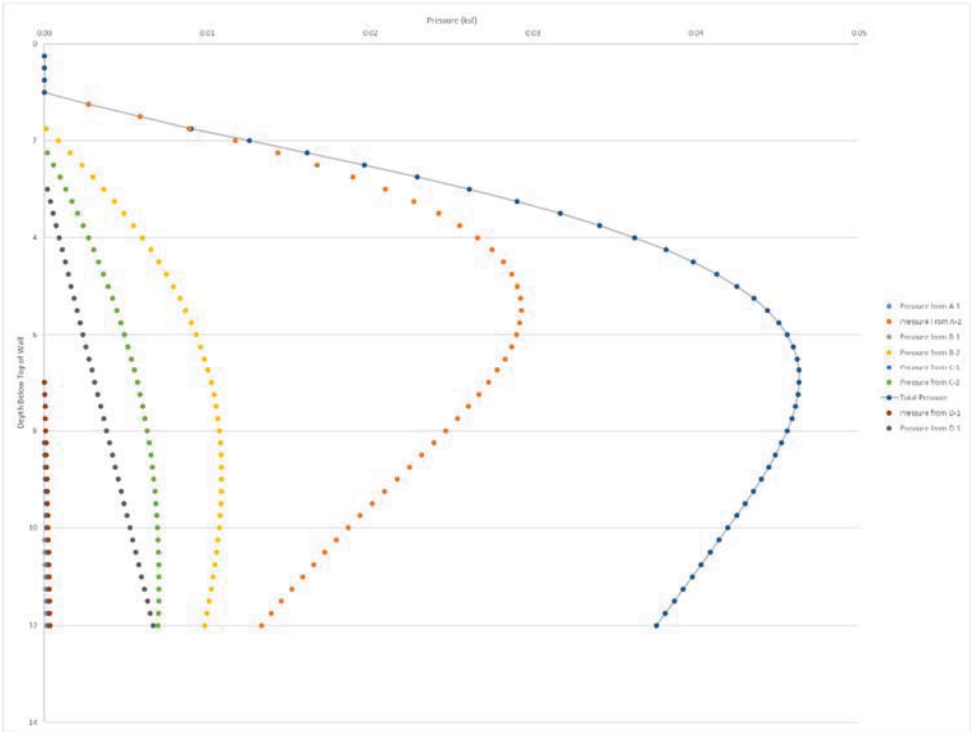
Maximum Pressure Diagram (Between Wheels)

Results-Wheel Line 10' from Wall:

DE60LF Bus:

Position along Wall Relative to Rear Wheel (2' spa. Typical), ft.	LOADING FROM BUS Lateral pressure (ksf) at depth below grade (ft)						
	0.25	2	4	6	8	10	12
33	0.000	0.000	0.007	0.012	0.014	0.015	0.014
31	0.000	0.002	0.012	0.017	0.019	0.019	0.017
29	0.000	0.004	0.017	0.023	0.024	0.022	0.020
27	0.000	0.007	0.022	0.027	0.027	0.025	0.022
25	0.000	0.008	0.023	0.029	0.029	0.026	0.023
23	0.000	0.007	0.021	0.027	0.027	0.026	0.023
21	0.000	0.004	0.016	0.022	0.024	0.024	0.022
19	0.000	0.001	0.011	0.017	0.020	0.021	0.021
17	0.000	0.000	0.006	0.013	0.017	0.019	0.020
15	0.000	0.000	0.003	0.010	0.015	0.018	0.020
13	0.000	0.000	0.002	0.010	0.016	0.019	0.020
11	0.000	0.000	0.003	0.012	0.018	0.021	0.022
9	0.000	0.000	0.007	0.016	0.022	0.024	0.025
7	0.000	0.001	0.014	0.023	0.028	0.029	0.029
5	0.000	0.004	0.021	0.031	0.035	0.034	0.032
3	0.000	0.009	0.030	0.039	0.041	0.039	0.036
0	0.000	0.013	0.036	0.046	0.046	0.042	0.038
-2	0.000	0.011	0.033	0.043	0.043	0.040	0.036
-4	0.000	0.006	0.026	0.035	0.037	0.036	0.033
-6	0.000	0.002	0.017	0.026	0.030	0.030	0.028
-8	0.000	0.000	0.010	0.018	0.022	0.024	0.023

Summary of Pressures at Depths and Locations Along Wall



Maximum Pressure Diagram (Typical at Rear Wheel)

SDOT
Seattle Department of Transportation

Project: 1st Ave Areaway	Designed By: RAB	Date: 10/13/18
Task: LL Vehicle Positioning	Checked By:	Date:
Activity No.:	Page:	of:

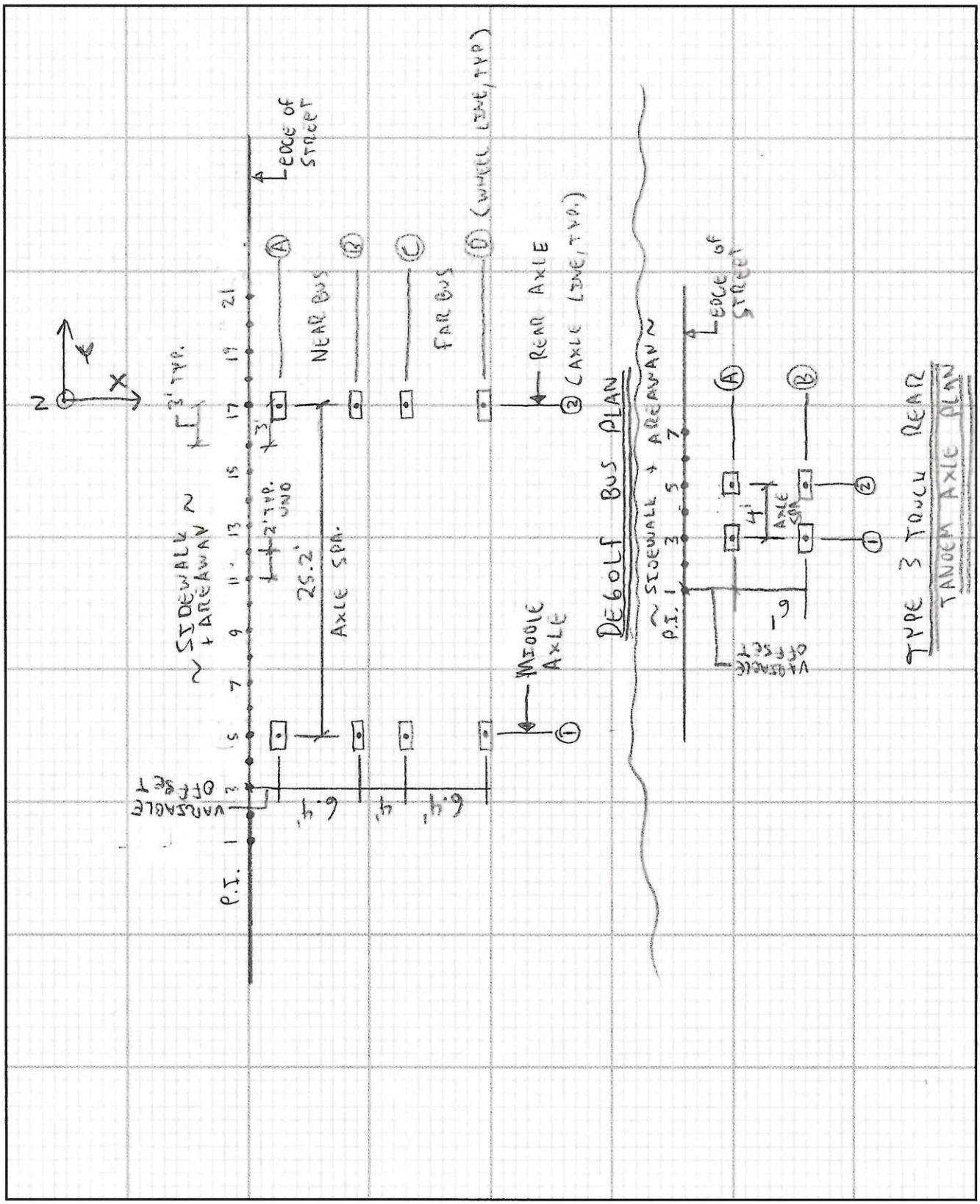


Table 1. Bus Axle Weights

Bus	# in Fleet	Gross Vehicle Weight (Empty / 130% PAX, lb)	Empty Axle Weights (lb)			100% PAX All Seats Filled Axle Weights (lb)			130% PAX Standing Overload Axle Weights (lb)		
			1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
2006 Metro Bus Fleet [A]											
New Flyer DE60LF	214	44,659 / 55,969	9,457	12,282	22,920	11,436	16,721	26,594	11,674	17,257	27,038
New Flyer D60LF	30	41,820 / 54,359	9,020	11,280	21,520	10,990	15,742	25,180	11,468	16,824	26,067
New Flyer D40LF	100	28,200 / 37,340	9,150	19,730	---	11,608	23,362		12,565	24,775	---
New Flyer D60	274	42,780 / 55,530	10,620	11,540	20,620	12,645	16,354	24,918	12,938	17,051	25,541
Gillig Phantom ETB	100	31,205 / 39,605	11,440	19,765	---	14,315	24,198		14,744	24,861	---
Gillig Phantom	95	25,970 / 32,015	7,791	18,179	---	9,511	21,679		9,782	22,233	---
Gillig Phantom	15	26,725 / 33,745	9,438	17,287	---	11,592	21,049		11,994	21,751	---
Gillig Phantom	395	29,420 / 37,610	10,920	18,500	---	13,795	22,933		14,142	23,468	---
Breda ADPB 350 [B]	59	49,500 / 61,112	12,740	16,610	20,150	15,253	19,421	23,588	15,773	20,861	24,478
MAN ETB [B]	46	40,440 / 53,310	12,100	14,220	14,120	14,000	18,670	17,640	14,490	20,320	18,500
ST Gillig Phantom	70	29,420 / 37,610	10,920	18,500	---	13,795	22,933		14,142	23,468	---
ST New Flyer D60LF	37	41,820 / 54,359	9,020	11,280	21,520	10,990	15,742	25,180	11,468	16,824	26,067
1993 Metro Bus Fleet [B]											
AM General Trolley 40'	109	25,900 / 34,900	8,320	17,580	---	11,140	21,660		12,090	22,810	---
AM General Diesel 40'	223	26,280 / 35,280	7,840	18,440	---	10,510	22,670		11,440	23,840	---
Flyer Diesel 40'	224	26,720 / 36,021	8,460	18,260	---	11,410	22,510		12,360	23,661	---
Flyer Diesel 35'	35	26,160 / 33,960	7,800	18,360	---	9,920	22,240		10,660	23,300	---
MAN Diesel 40'	157	28,240 / 37,090	10,000	18,240	---	12,300	22,690		13,160	23,930	---
MAN Diesel 60' 1400-1550	150	35,460 / 49,720	10,660	15,680	9,120	13,030	20,280	13,110	13,570	22,090	14,060
MAN Diesel 60' 2000-2201	202	36,680 / 50,520	12,240	15,320	9,120	14,400	19,840	13,090	14,920	21,580	14,020
Man ETB 60'	46	40,560 / 53,310	12,220	14,420	13,920	14,000	18,670	17,640	14,490	20,320	18,500
Breda 60'	236	48,850 / 61,112	13,267	15,433	20,150	15,253	19,421	23,588	15,773	20,861	24,478

[A] Hansen calculations 2 April2007; Metro Transit / King County Department of Transportation Fleet Specifications

[B] Metro scale weights 28 May 1993 (provided during Chinn / De Boldt research)

Exceeds standard 20,000 lb single axle weight limit standard RCW 46.44, 23 USC 127

Exceeds new federal 24,000 lb transit axle weight standard

King County
METRO TRANSIT

1100-1194 Gillig

Weight- Empty- Total (LB.)	25,970
*First Axle	7,791
*second axle	18,179
Weight- Loaded- Total (LB.)	

2300-2573 New Flyer

Weight- Empty- Total (LB.)	42,780
*First Axle	10,620
*second axle	11,540
*third axle	20,620
Weight- Loaded- Total (LB.)	

2599, 2600-2812 New Flyer

Weight- Empty- Total (LB.)	45,935
*First Axle	9,595
*second axle	12,230
*third axle	24,110
Weight- Loaded- Total (LB.) at 116 passengers	63,335

2870-2899 New Flyer

Weight- Empty- Total (LB.)	43,199
*First Axle	9,698
*second axle	11,741
*third axle	21,760
Weight- Loaded- Total (LB.) at 116 passengers	60,599

3185-3199 Gillig

Weight- Empty- Total (LB.)	26,725
*First Axle	9,438
*second axle	17,287

3200-3594 Gillig

Weight- Empty- Total (LB.)	29,420
*First Axle	10,920
*second axle	18,500

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3600-3699 New Flyer

Weight- Empty- Total (LB.)	31,870
*First Axle	9,150
*second axle	19,730

3700-3759 New Flyer

Weight- Empty- Total (LB.)	28,880
*First Axle	8,500
*second axle	20,400
Weight- Loaded- Total (LB.) at 61 passengers	40,280

4300-4409 New Flyer

Weight- Empty- Total (LB.)	31,649
*First Axle	10,566
*second axle	21,083
Weight – Loaded – Total at 76 passengers	43,049

4500-4563 New Flyer

Weight- Empty- Total (LB.)	42,941
*First Axle	9,516
*second axle	14,223
*third axle	23,260
Weight – Loaded – Total at 116 passengers	60,491

4601-4603 Proterra

Weight- Empty- Total (LB.)	29,830
*First Axle	13,424
*second axle	16,406
Weight- Loaded- Total (LB.) at 53 passengers	37,780

4604-4611 Proterra

Weight- Empty- Total (LB.)	30,360
*First Axle	13,580
*second axle	16,780
Weight- Loaded- Total (LB.) at 53 passengers	38,310

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METRO TRANSIT

6000-6019 BRT New Flyer

Weight- Empty- Total (LB.)	49,225
*First Axle	10,100
*second axle	14,620
*third axle	23,260
Weight- Loaded- Total (LB.) at 116 passengers	66,625

6020-6035 BRT New Flyer

Weight- Empty- Total (LB.)	47,520
*First Axle	10,100
*second axle	14,420
*third axle	23,440
Weight- Loaded- Total (LB.) at 116 passengers	66,625

6040-6073 BRT New Flyer

Weight- Empty- Total (LB.)	47,660
*First Axle	10,500
*second axle	14,060
*third axle	23,460
Weight- Loaded- Total (LB.) at 116 passengers	65,060

6075-6107 BRT New Flyer

Weight- Empty- Total (LB.)	47,660
*First Axle	10,500
*second axle	14,060
*third axle	23,460
Weight- Loaded- Total (LB.) at 116 passengers	65,060

6108-6117 BRT New Flyer

Weight- Empty- Total (LB.)	47,660
*First Axle	10,500
*second axle	14,060
*third axle	23,460
Weight- Loaded- Total (LB.) at 116 passengers	65,060

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METRO TRANSIT

6200-6219 BRT New Flyer

Weight- Empty- Total (LB.)	47,520
*First Axle	10,100
*second axle	14,420
*third axle	23,440
Weight- Loaded- Total (LB.) at 116 passengers	64,920

6220-6239 New Flyer

Weight- Empty- Total (LB.)	45,380
*First Axle	11,080
*second axle	12,360
*third axle	21,940
Weight- Loaded- Total (LB.) at 116 passengers	62,780

6813-6834 New Flyer

Weight- Empty- Total (LB.)	47,980
*First Axle	10,100
*second axle	14,620
*third axle	23,260
Weight- Loaded- Total (LB.) at 116 passengers	65,380

6835-6850 AWV New Flyer

Weight- Empty- Total (LB.)	47,620
*First Axle	10,340
*second axle	14,000
*third axle	23,280
Weight- Loaded- Total (LB.) at 116 passengers	65,020

6851-6864 AWV New Flyer

Weight- Empty- Total (LB.)	47,620
*First Axle	10,340
*second axle	14,000
*third axle	23,280
Weight- Loaded- Total (LB.) at 116 passengers	65,020

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6865-6921 New Flyer

Weight- Empty- Total (LB.)	47,620
*First Axle	10,340
*second axle	14,000
*third axle	23,280
Weight- Loaded- Total (LB.) at 116 passengers	65,020

6922-6935 UPA New Flyer

Weight- Empty- Total (LB.)	47,620
*First Axle	10,340
*second axle	14,000
*third axle	23,280
Weight- Loaded- Total (LB.) at 116 passengers	65,020

6936-6999 +6800 New Flyer

Weight- Empty- Total (LB.)	47,620
*First Axle	10,340
*second axle	14,000
*third axle	23,280
Weight- Loaded- Total (LB.) at 116 passengers	65,020

7001-7199 UPA Orion

Weight- Empty- Total (LB.)	31,376
*First Axle	10,083
*second axle	21,293
Weight- Loaded- Total (LB.) at 69 passengers	41,726

7200-7259 New Flyer

Weight- Empty- Total (LB.)	30,200
*First Axle	9,950
*second axle	20,250
Weight- Loaded- Total (LB.) at 76 passengers	41,600

7300-7429 Gillig

Weight- Empty- Total (LB.)	29,300
*First Axle	9,380
*second axle	19,920
Weight- Loaded- Total (LB.) at 52 passengers	37,100

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METRO TRANSIT

8000-8084 New Flyer

Weight- Empty- Total (LB.)	43,120
*First Axle	10,560
*second axle	14,020
*third axle	23,020
Weight- Loaded- Total (LB.) at 116 passengers	60,520

8100-8149 New Flyer

Weight- Empty- Total (LB.)	43,120
*First Axle	10,560
*second axle	14,020
*third axle	23,020
Weight- Loaded- Total (LB.) at 116 passengers	60,520

8150-8199 New Flyer

Weight- Empty- Total (LB.)	43,120
*First Axle	10,560
*second axle	14,020
*third axle	23,020
Weight- Loaded- Total (LB.) at 116 passengers	60,520

8200-8299 New Flyer

Weight- Empty- Total (LB.)	43,120
*First Axle	10,560
*second axle	14,020
*third axle	23,020
Weight- Loaded- Total (LB.) at 116 passengers	60,520

Attachment 3 – Photos

Photo 1: Areaway 401 – Crack at top of wall

Photo 2: Areaway 401 - Top of wall condition

Photo 3: Areaway 401 - Top of wall condition

Photo 4: Areaway 401 - Top of wall condition

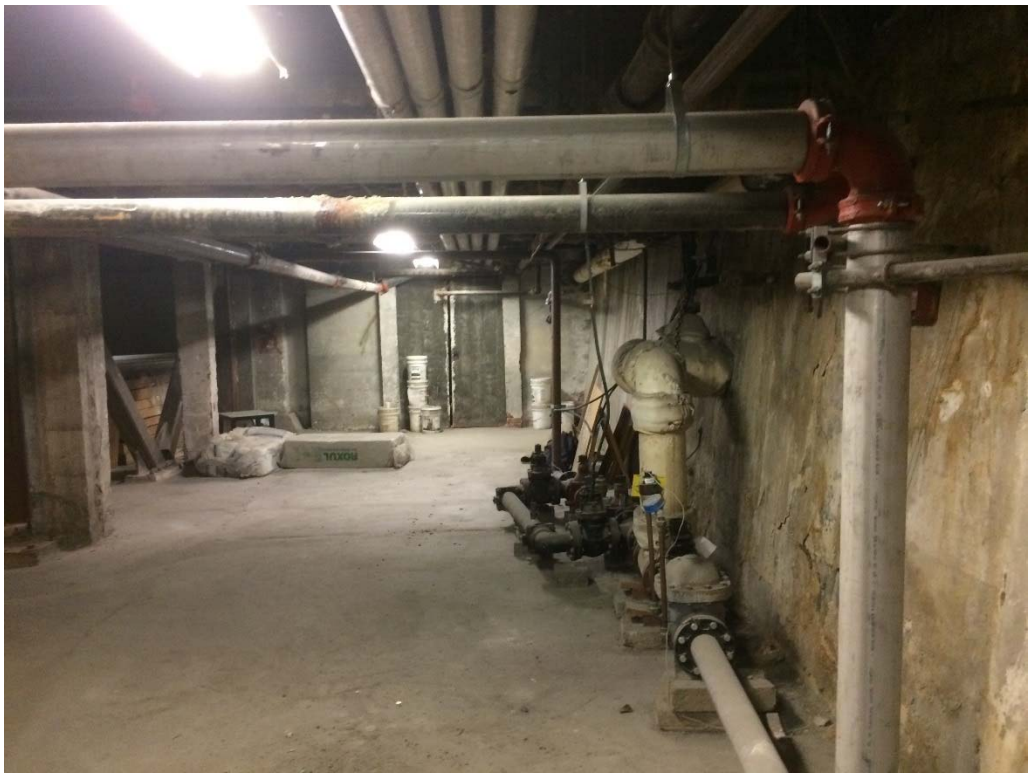

Photo 5: Areaway 401

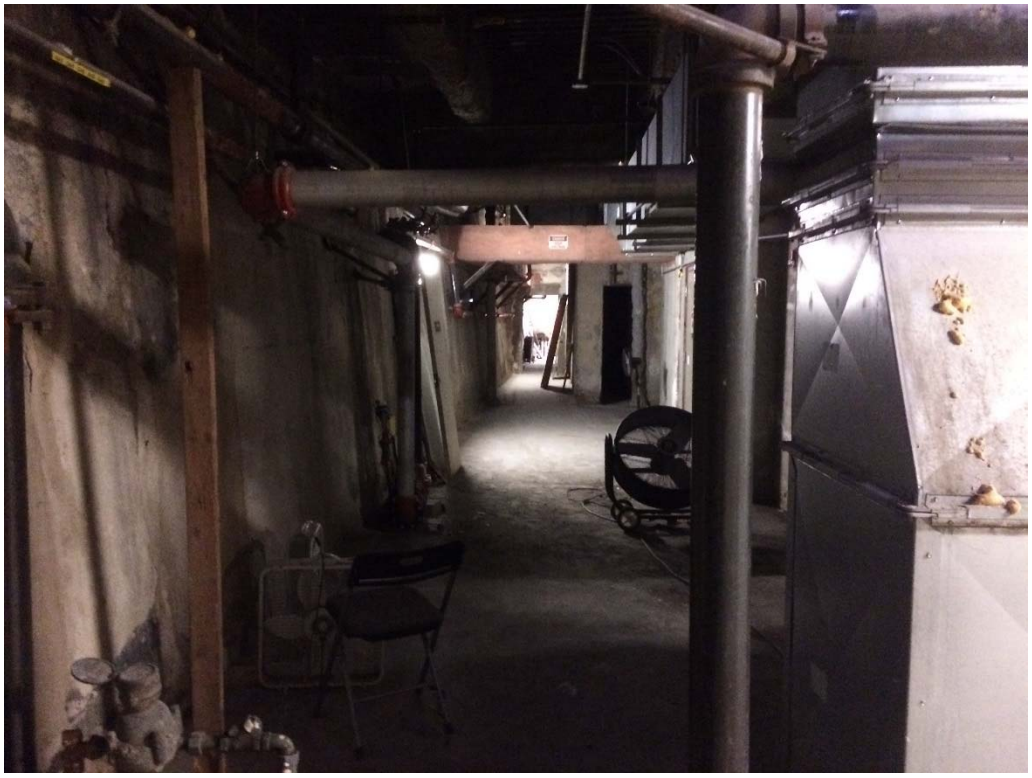

Photo 6: Areaway 401

Photo 7: Areaway 202 - Top of wall at sidewalk

Photo 8: Areaway 202 brick wall

Photo 9: Areaway 202 utility penetration in wall

Photo 10: Areaway 202 partially filled blockout in wall

Photo 11: Areaway 202 bottom of sidewalk

Photo 12: Areaway 202 - brick wall condition

Photo 13: Areaway 202 - sidewalk above areaway

Photo 14: Areaway 301

Photo 15: Areaway 301 existing tilt plate and strain gage

Photo 16: Areaway 301 - exposed rubble masonry

Photo 17: Areaway 301 - exposed rubble masonry

Photo 18: Areaway 301

Photo 19: Areaway 301 sidewalk support beams